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MANUAL

FOR

GEOGRAPHY 1

For the Use of the Teachers and Students
in the High Schools of Alberta

BY

M. J. HILTON
Head of the Science Department, Edmonton Technical School

AUTHORIZED BY THE DEPARTMENT OF EDUCATION

Reprint of 1925 Edition

EDMONTON:
Printed by W. D. McLean, King's Printer
1929

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PREFACE

The preparation of this manual was undertaken at the request of the Department of Education of the Province of Alberta.

During its preparation the writer has endeavored to keep constantly in mind the peculiar needs of the rural high schools. This type of geographical study is quite a new venture in Canadian schools. There is, therefore, not available any single text which adequately compasses the outline of the course as laid down in the Departmental Handbook for Secondary Schools. This fact has made the compilation of the manual difficult and has necessitated continuous search for material, both for general as well as statistical information. The writer ventures to hope that the teachers of the Province will find in the text a sufficient body of up-to-date geographical information to enable them to adequately present the subject.

In conclusion, the writer wishes to express his indebtedness to the works of the following persons, which have been freely used and quoted from in preparing the text: Ellsworth Huntington, S. W. Cushing, J. Russell Smith, V. C. Finch, O. E. Baker, R. H. Whitbeck, J. W. Gregory, C. B. Thurston, O. J. Howarth, A. J. and F. D. Herbertson, H. H. Powers, J. C. Cunningham, A. Guyot, J. Bruhnes, G. C. Chisholm, H. T. Vulté, Sadie B. Vanderbilt, A. L. Curr, H. E. Gregory, A. G. Keller, A. L. Bishop, E. Prothero, A. P. Brigham, F. E. Williams, and T. W. F. Parkinson. Also to the publications and reports of The Geological Survey of Canada, The Natural Resources Intelligence Branch, The Department of Trade and Commerce, The Dominion and Provincial Departments of Agriculture, The Department of Mines of the Provinces of Ontario, Quebec, and British Columbia, The Mines Branch of the Province of Alberta, The Department of Marine and Fisheries, The Scientific and Industrial Research Council of Alberta. For statistical authorities the following have been principally used: *The Statesman's Year Book, 1925, The Year Book of Canada, 1924, The World Almanac, 1925, Whitaker's Almanac, 1924, Heaton's Commercial Handbook of Canada, 1925,* and special reports of the Dominion Bureau of Statistics.

GEOGRAPHY

PART I.

WEATHER AND CLIMATE

CHAPTER I.

Weather.

1. Weather may be defined as the condition of the atmosphere as to temperature, barometric pressure, wind, clouds, etc., at any given time.

2. The Most Outstanding Characteristic of Weather is its Changeableness. These changes in the weather play a most important part in our lives. In fact, we regulate our lives to a great extent by them. Ever since man began to think about the many things which were happening around him, the weather has especially interested him.

This is not surprising, since it made a great deal of difference to his comfort whether it were warm or cold, wet or fine.

The weather also affects the food supply so strongly, that the danger of starvation forced man to take notice of any thing which would make him weather-wise.

Without some knowledge about the signs these changes always send before them, successful farming would be impossible. Again, if the sailors, venturing over the ocean in their ships, could not read the signs of the weather ,they would find their occupation much more dangerous than they do at present.

3. Weather Proverbs. In consequence of the farmer and sailor being so dependent upon weather changes it is not surprising to find that they have collected a lot of valuable knowledge about the signs of approaching weather changes.

They hand down this knowledge from father to son in proverbs and simple rhymes, *e.g.*:

"A storm of hail
Brings frost in its tail."

Or—

"The rainbow in the morning
Is the shepherd's warning.
The rainbow at night
Is the shepherd's delight."

Again—

"Evening red and morning grey
Are sure signs of a pleasant day."

Many of these sayings are simple nonsense, others have some foundation in fact, but are of purely local application, whilst some have been found to be generally true. They do tell us, however, that man, in all ages, has tried to foretell the changes in the weather.

4. Modern Weather Study. The weather is no longer studied in this hit or miss fashion. Instead, it is recognized by all civilized nations as a most important branch of science. The governments of all the enlightened nations maintain large forces of trained observers, whose special duty it is to observe, record and transmit to a central office the weather conditions in their different localities. From these daily observations are supplied the daily weather maps, and from them forecasts of the kind of weather expected for the next twenty-four hours are issued. In addition to the daily forecasts, there are issued special warnings of expected gales, floods, snowstorms, and drifts. This information is eagerly looked for by farmers, sailors, railway companies, aviators, insurance companies and many other classes of workers.

Figures illustrative of the value of the work of Meteorological Forecasts and Warnings for the Dominion are not available, but the following from the United States will give an idea as to their value to the nation. "The Marine Warnings of the service U.S. Weather Bureau have been so well made that in over ten years no protracted storm has reached any point in the United States without danger warnings being displayed well in advance. As a result of these warnings the loss of life and property has been reduced to a minimum, being doubtless not more than 25% of what it would have been without this extensive system.

"The United States Government spends one and a half million dollars annually on its weather bureau. . . . . It is not uncommon for the bureau to distribute 100,000 telegrams and messages inside the space of one or two hours, so that nearly every city, village, and hamlet receives the information in time to profit thereby. What this means to the farmer and shipper is well illustrated by the fact that it was gathered from those personally interested, from statements relative to the sweep of one cold wave, which showed that over $3,400,000 worth of property, that would have been destroyed by the low temperatures, was saved."—(Quoted from *Weather and Weather Instruments for the Amateur,* by P. R. Jamieson, F.R. Met. Soc.)

5. Organization of the Dominion Meteorological Service. In a country so predominantly agricultural as the Dominion of Canada, accurate forecasting of the approaching weather changes together with an understanding of the climatic conditions of the various parts of the country are vitally necessary to successful business. Realizing this, the Dominion Government maintains for this purpose a Meteorological Service.

The service is a branch of the Department of Marine and Fisheries. The head office is at Toronto, with Sir Frederick Stupart in charge as Director of the Meteorological Service.

The cost of running this service for the fiscal year 1922-23 was $251,583.

The first official establishment for meteorological work in the Dominion occurred in 1840, when the British Government established a Magnetic and Meteorological Observatory at Toronto.

In the spring of 1871, a grant of $5,000 was made by the Dominion Government for the promotion of meteorological research and gave considerable impetus to the movement, which had been carried on from 1869 to 1871 by purely voluntary organization.

In 1873 the preparation of a daily synchronous weather chart was commenced, but the information received at Toronto was quite inadequate to admit of daily weather forecasts and the issue of storm warnings. However, through the courtesy and goodwill of the chief signal officer at Washington, warnings of expected storms were sent to Toronto, and thence forwarded to the various districts likely to be affected. By 1876 there were 15 stations in Canada reporting three times daily to Toronto, and reports from upwards of 50 American stations were also received at the observatory. The storm signal display stations had also been increased to 37 and observing stations of all classes numbered 115. Forecasts were first issued during the summer of 1876, a weather chart with the probabilities for the ensuing 24 hours being prepared each morning at 10 o'clock, and furnished to the Marine Exchange Board in Toronto for public inspection. After September 1, 1876, warnings were issued from the observatory without waiting for advice from Washington, and in October the daily forecasts were first printed in the Toronto evening papers. Thus the meteorological service became completely established. In the 50 years which have intervened, the growth of the service has been steady, and its activities have greatly increased.

"In July, 1923, there were 686 stations furnishing reports to the central office. At 316 of these stations the observer is paid a salary for duties performed, but it is only at Victoria, Vancouver, Edmonton, Moose Jaw, Winnipeg, Quebec and St. John that the observers are paid for whole time work, and in most instances the stipend is very small. At 360 stations the observing is performed voluntarily by men who take an interest in weather records and this makes a valuable contribution to the country."—(Extract from Report of the Director of the Meteorological Service, fiscal year 1922-23.)

6. Weather Forecasting Service. The particular work which brings the service most closely into the public eye is weather forecasting. Forecasts are issued from the central

office, Toronto, and all parts of the Dominion east of the Rocky Mountains, and from Victoria for British Columbia.

For the purposes of the weather map, on which forecasts are based, two daily reports, 8 a.m. and 8 p.m. eastern standard time, are telegraphed to the central office in Toronto from 39 stations in Canada, from 5 in Newfoundland and from Bermuda. Most of these reports are immediately forwarded to Washington, while Toronto receives about 100 similar reports from stations in the United States. Each report includes the reading of the barometer reduced to sea level, the temperature, the direction and velocity of the wind, and precipitation, if any.

All these reports having been entered into a map of North America, lines called "isobars," connecting places with the same barometric pressure, are drawn, and show graphically the distribution of the pressure; the areas of high and low pressure are thus clearly marked out. Noting the movements of these areas as shown by previous maps, the forecasting official, from long experience and a knowledge of the many physical laws which govern atmospheric phenomena, is able to judge of changes likely to occur over subsequent periods of from one to several days.

Supplementary to this weather chart of America, a chart is also prepared daily containing reports from Europe and Alaska, and from the Azores and several sub-Arctic stations in the North Atlantic. This chart is very helpful, showing as it does how intimately connected are the changes in all parts of the globe. The weather forecasts are issued twice a day, namely, at 10 a.m. and at 10 p.m., and are usually in both instances for the ensuing 36 hours. At times the forecast is more extended, but there is no regular issue covering a longer period. The general means of disseminating the forecasts is by telegraph, and arrangements exist whereby every telegraph office in Canada should receive them without delay.

In many parts of the Dominion, a copy of the forenoon forecast is supplied to central telephone offices and furnished to rural subscribers and shipping people when asked for. The forecasts are also broadcasted from all the Government wireless stations for the benefit of shipping near the Atlantic coast and on the Great Lakes.

In addition to the regular bi-daily issue of forecasts, special warnings of expected gales are telegraphed to agents at over 100 ports, where storm signals are displayed, and special notice is telegraphed to the railways when snow storms and drifts are expected. The daily weather map is printed each morning in the Toronto and Winnipeg offices, and several hundred copies are distributed to commercial companies, insurance companies, railways, and many other business concerns. In addition a large number of public schools and high schools receive the map, and as a result, a good knowledge of atmospheric changes is not uncommon among teachers, who, it is found, take pleasure in explaining the maps to their pupils.

A very similar weather map is prepared at Victoria meteorological office, whence forecasts are issued for British Columbia and the sea routes adjacent thereto.—(Extract from contribution "The Meteorological Service of Canada," by Sir Frederick Stupart, Director, in *The Canada Year Book,* 1922-23.)

7. Other Activities of the Meteorological Service in Canada—

Agricultural Meteorology — This division publishes the monthly weather map. This map is issued on the 7th of each month and contains a summary of the condition of crops, the progress of agricultural operations, and a graphical survey of the weather of the month just past. This division also studies the effect of weather changes on the growth, yield, and quality of crops, more especially as this effect is modified by various methods of cultivation. Work on sugar beets for sugar production has been published, and work on oats, wheat, and potatoes is progressing.

Magnetic Observations. The original object of the British Government when the observatory was established in 1840 was the making of magnetic observations.

Few people have any idea of the great importance of the study of terrestrial magnetism. Suffice it to say here, that upon it depends the safety of ships at sea, the accuracy of our land surveys, the safety of miners underground, and many other important matters. The magnetic work has been carried on continuously since 1840 and forms one of the longest and most valuable records in the world.

In 1916 another magnetic observatory was established near Athabasca, Alberta, and a continuous record of the magnetic declination has since been obtained there, giving data very necessary to the Dominion surveyors as well as to pure science.

Atmospheric Physics. Studies are made of the conditions of the atmosphere at considerable heights above the surface of the earth. This, it is expected, will yield very important data for the use of aviators, wireless operators, and others. The sending up of balloons carrying meteorographs in conjunction with all other meteorological services on "international days" is part of the work of this division.

Seismology or earthquake study also forms a branch of the work of the service.

Time Service. The service also supervises the time service of the Dominion. The Toronto, Victoria, Montreal, Quebec, and St. John, N.B., stations make the necessary stellar observations and send out time signals. The regulation and comparison of ships' chronometers, watches, and clocks is also carried out by the meteorological service. It also gives the time daily to the Canadian National Railway.

8. Accuracy of Weather Forecasts. Many people are very contemptuous regarding the accuracy of weather forecasts. This is largely due to the fact that they fail to distinguish between the conscientious efforts of the trained meteorologist and those of the cranks and impostors who hang about the outskirts of the profession. Another reason is also that they always remember and magnify the failures, but seldom instance the success of the forecaster.

What are the actual figures? In the report of the director of the Meteorological Service of Canada for 1922-23 we find the following figures:

> "The percentage of verification of forecasts for the year was 84.9, and of storm warnings, 88.5."

The Dominion maintains a station at Cape Race to which point bi-daily weather bulletins are telegraphed, that they may be broadcasted for the benefit of ships on the near Atlantic. Mr. Sharp, reporting on this station for the Minister of Marine for Newfoundland, says:

"The work of broadcasting weather information and forecasts from Cape Race has grown enormously; in fact it is now a service of first importance to Canadian and international shipping in touch with Cape Race. Mr. Kerton, the manager of the Cape Race wireless station, said he could not express too strongly his appreciation and admiration of the forecasts sent down from our office. He said he would like, just to show us the value of the work, to have us discontinue the service for even two weeks; there would be such an outcry from shipping of all nations that we would be in no doubt as to the esteem in which the forecasts are held. The work of sending out forecasts on request has grown to such a volume that if we were paying for it at the ordinary commercial rate it would cost one hundred thousand dollars per year; in fact such requests are so numerous that they are interfering with the commercial work of the Marconi Company, and the Government will be asked for some relief in this connection."

Such results as these hardly warrant the contempt in which some people hold the services of the true weather forecaster.

9. Principal Observations Made at a Meteorological Station. These comprise the following routine observations:

(1) The Pressure of the Atmosphere.
(2) The Temperature.
(3) The Precipitation.
(4) The Humidity.
(5) The Wind.
(6) The Hours of Sunshine.
(7) The State of the Sky.

At certain special stations various other observations may be made; these will be dependent upon the particular work assigned to that station.

At the permanent stations and the observatories, these observations are, as far as possible, obtained by means of self-registering instruments. The greater part of the work of observation is accomplished by means of the ordinary type of instrument, which has to be read at stated intervals, and requires re-setting after each reading.

10. Principles of Instruments Used—

(*a*) *The Barometer*—This instrument is used to determine the pressure of the atmosphere.

A discussion of the principle involved and description of the instrument may be found in *The High School Physics,* page 95, secs. 98 to 106 inclusive.

The form generally used in the stations is the Cistern Type, figs. 116 and 117, *High School Physics.*

On page 161, fig. 198, will be found an illustration and description of the manner in which this type of barometer is made to act as a self-recording type of barometer. Sometimes another form of self-regulating barometer is used, called a "barograph." This is an aneroid barometer equipped with a rotating drum and a pen attached to a pointer. As the pressure changes the pen moves up and down, tracing its course upon a piece of squared paper attached to the moving drum. An illustration of this form of barometer can be found on page 12 of Caldwell and Eikenberry's *General Science.*

The barometer is perhaps the meteorologist's most useful instrument, yet its value is very much overrated by the average "man in the street," who sometimes calls it the "weather glass." Teachers cannot over-emphasize the fact that the weather words on an aneroid or other barometer are quite useless, and that if one wishes to use the barometer as a weather indicator, he must learn the principles governing its action.

(*b*) *The Thermometer and Thermometer Shelter.* The thermometer is the instrument used to measure the heat condition of the atmosphere. Every station is equipped with three thermometers, viz.: A standard thermometer, a maximum thermometer, and a minimum thermometer.

Descriptions of these and a discussion of the principles involved in their action will be found in *The High School Physics,* Chapter 24, secs. 233 to 242.

(*c*) *The Thermometer Shelter.* For accurate observations the thermometer must be exposed in specially constructed boxes with sides protected with "louvres," which protect them from direct sunshine, rain, and draughts, yet allow the air to circulate freely. These boxes are called "Stevenson Screens" because they were introduced by Thomas Stevenson, the father of R. L. Stevenson, author of *Treasure Island,* etc.

Probably no record of the meteorologist is the subject of so much criticism as the temperature record. This is due to the general public failing to understand the difference between the

scientific and unscientific methods of using a thermometer for weather-measuring purposes. The layman wishing to be somewhat weather-wise, either purchases a thermometer, or consults the impressive-looking article exposed on some street corner. He then compares this with the temperature records in his evening paper. They do not agree. He finds that they very rarely agree. In summer the official record is usually too low, and in winter the figures are usually too high. Immediately he accuses the meteorological service with juggling with the figures for some ulterior purpose of the Government. What are the real facts? They are simply this: The weather-man wants the true temperature of the air and not that of something else. Now a thermometer exposed to direct sunshine records its own temperature (that is, the temperature of the glass and mercury)—and nothing else. A thermometer "in the shade" (for example, under a tree) comes nearer to showing the true air temperature; but it is exposed to radiations from surrounding objects and its readings will vary with the nature and distance of these objects.

Meteorological thermometers are therefore placed inside these "Stevenson Screens" which have the effect of largely protecting them from radiation, and again being made to a standard size they set up "standard conditions" around the thermometers and so make it possible to obtain comparable readings of the temperature of the air at different places.

It must be remembered that the temperature of a city street is a very local and indefinite thing, and is just as much an artificial temperature as that of a room. It could not be considered for a moment for use on a weather map.

(*d*) *The Rain Gauge.* This is the instrument used for measuring the rainfall. One of the most important records of an observing station is that of the rainfall. This is so for many reasons, but chiefly because it may mean the difference between success and failure of a valuable crop, or it may determine the type of crop suited to the district, yet again it may mean the difference between an ample supply and a scarcity of drinking water. The standard rain gauge is essentially a deep metal funnel 5 inches in diameter, fitting on a metal cylinder. Inside the cylinder is a can or bottle which receives all the rain falling into the funnel. Special care is taken by the makers to ensure that the rim of the gauge is circular and strong enough to keep its shape. The edge is bevelled outwards. Accompanying the gauge is a graduated measuring jar which shows in hundredths of an inch how deep the water would have been if it had collected in the cylinder itself.

Rain gauges should be placed in an exposed position, where they will not be sheltered from rain by neighbouring objects. The rim must be accurately horizontal and one foot above the ground, in order that no rain may splash into it from the ground.

Rainfall records include not only rain but also water which falls in the form of snow and hail. The amount of water which they yield on melting is added to the ordinary rainfall and the total is called "precipitation."

The official practice in Canada is as follows: Under the collective term "precipitation" is included all moisture which has been precipitated from the atmosphere upon the earth: rain, snow, hail, sleet, etc. The amount of moisture is conveniently measured by determining the depth to which it has accumulated upon an impervious surface, and is always expressed in inches in depth. The total depth of snow is tabulated separately, but is added to the depth of rain after division by ten. An extended series of experiments in melting and measuring snow having been collated, the rule was deduced that a given fall of snow will, in melting, diminish on the average to one-tenth of its original depth. This rule is used in practice. All solid forms of precipitation other than snow are included in the tables of rain.

(*e*) *The Hygrometer.* This instrument is used to measure the humidity of the atmosphere. Humidity is an element of the weather that is far more often talked about than understood.

Humidity may be defined as the state of the atmosphere with respect to the amount of moisture it contains in the gaseous form, such gaseous form being called water vapor. This water vapor cannot be directly perceived by the senses like liquid water can. It is, however, always present in the atmosphere. The amount of water vapor that may be held by the air at any given time depends entirely on the temperature of the air, and upon nothing else.

The amount of water vapor that is actually present in the air at any given time is called the "absolute humidity" and may depend on several things.

The actual dryness or moisture of the atmosphere depends not upon the actual amount of water vapor actually present, but upon the *proportion* between the amount of vapor the air actually contains and the amount it could contain at the same temperature.

The dampness of the air, measured in this way, is called its "relative humidity." It is usually expressed as a percentage of the maximum amount of vapor possible at the same temperature. A relative humidity of less than 60% is considered dry, while a relative humidity of 85% is considered to be damp.

There are many forms of the hygrometer, but the ones most often seen in weather-observing stations are of the wet and dry bulb types. A complete description of this type is to be found in *The High School Physics,* page 259, sec. 280. In the same place will be found the table necessary for determining the relative humidity by this method.

A variation of this form of hygrometer, called a "psychrometer" is often used at observing stations. It is simply the same instrument provided with a handle so that it may be whirled around. The method of reading and calculating is precisely that given in *The High School Physics,* page 259.

(*f*) *The Anemometer.* This is the instrument used to determine the velocity of the wind. It consists of four hemispherical cups, fixed at the ends of two crossed arms, which revolve horizontally in the wind. In the Robinson Anemometer the arms are two feet long and the cups nine inches across. The spindle on which they are fastened is connected with an index dial. This dial shows the number of revolutions they make in a certain time. From the figures thus obtained and a series of tables the velocity and force of the wind may be read off.

Many observing stations are not equipped with anemometers. In this case the observer uses the Beaufort wind scale to assist him in estimating the velocity of the wind. The following table gives the Beaufort wind scale.

Beaufort Number.	Description.	Effect.	Speed in miles per hour.
0.	Calm.	Calm, smoke rises vertically.	0–1
1.	Light Air.	Direction shown by smoke, but not by wind vanes.	1–3
2.	Slight breeze.	Wind felt on face, leaves rustle.	4–7
3.	Gentle breeze.	Leaves and small twigs in constant motion.	8–12
4.	Moderate breeze.	Raises dust and loose paper; moves small branches.	13–18
5.	Fresh breeze.	Small trees in leaf begin to sway; crested wavelets form on inland waters.	19–24
6.	Strong breeze.	Large branches in motion, umbrellas used with difficulty.	25–31
7.	High wind.	Whole trees in motion; inconvenience felt when walking against wind.	32–38
8.	Gale.	Breaks twigs off trees, generally impedes progress.	39–46
9.	Strong gale.	Chimney pots and slates removed.	47–54
10.	Whole gale.	Trees uprooted. Considerable damage to houses.	55–63
11.	Storm.	Widespread damage; very rare inland.	64–75
12.	Hurricane.	.....	Above 75

(*g*) *The Sunshine Recorder.* At selected stations sunshine recorders are installed. There are several forms of these, but the commonest form is the Campbell-Stokes Sunshine Recorder. This works on the burning-glass principle. It consists of a globe of crown glass exactly four inches in diameter. A semi-circle of brass is arranged behind it at a distance equal to the focus of the glass globe. A card, printed with a scale, is placed in the semi-circle and when the sun is shining it scorches the paper.

As the sun moves across the heavens, its image moves along the card in the opposite direction, and if it is shining with sufficient brightness it burns a line along the time card. Thus

the sun is made to write its own record. There are also electrical sunshine recorders which are used at some of the larger stations.

(*h*) *The State of the Sky.* There is no instrument which is able to record this condition. It is made by personal observation, according to a scale of notation devised by Admiral Beaufort and called the Beaufort Notation. Copies of this notation may be found in any good encyclopedia, or text on meteorology.

11. Practice in the Use of Simple Forms of Some of the Instruments in School. There should be no difficulty in this regard, since barometers, thermometers, hygrometers, and rain gauges will be the only ones available.

All except the rain gauge are fully described and exercises provided for in the General Science Text for Grade IX or in *The High School Physics.*

To Make a Simple Rain Gauge. Obtain a cylindrical tin vessel, the deeper the better, turn it upside down on a sheet of squared paper graduated in centimetres and millimetres. Now with a sharp pencil mark the outline of the opening on the paper. Then count the squares to obtain the area of the opening. Set the vessel mouth up in an exposed place, so that—

1. The rim is truly horizontal.
2. It will not be sheltered by any near-by object.
3. It will be high enough from the ground to prevent splashes entering the opening.

Every morning at a stated time pour out any collected rain into a measuring jar graduated in cubic centimetres; read off the volume of water and divide it by the area of the opening. The quotient is the depth in centimetres of the water which has fallen on an area equal to that of the opening. The same depth must of course have fallen on any other area at the same place and time. To obtain the answer in inches divide the quotient obtained by your first division by 2.54, since there are 2.54 centimetres in an inch.

An inch of rain in a gauge does not appear to be very much, but it will be interesting to calculate the weight in tons, and the volume in gallons of an inch of rain on an acre. (Water weighs 62½ lbs. per cubic foot; and 10 lbs. of water measures one gallon.)

The use of observations in preparation of weather charts at the central office. Charting of pressure observations of different stations in order to determine areas of high and low pressure. The above items have already been discussed in Section 6, "Weather Forecasting Service." Other convenient references will be found in Caldwell and Eikenberry's *General Science*, Chap. IV, and also in *The High School Physics*, Merchant and

Chant (Rev. Ed.), page 100, paragraph 105. *The Ontario High School Physical Geography* also contains useful references on pages 191 to 210 inclusive.

12. Cyclones. If the weather maps in Caldwell and Eikenberry's *General Science,* figs. 24, 25, and 26, pages 39, 40, and 41, are carefully studied, it will be seen that they are covered with a series of roughly elliptical lines. These lines are termed "Isobars" and join all stations having equal barometric pressures. Notice that they appear to form roughly concentric groupings around areas marked "low" and "high."

Again notice that each station is indicated by a blackened or open circle having an arrow pointing from it. The open circles denote that the sky was clear at that station, a blackened circle indicates cloudy weather, whilst the arrow points out the direction of the wind.

The dotted line marks the "Isotherm" or freezing temperature. If now the wind arrows are closely examined, it will be seen that the winds are blowing spirally inwards, in an anti-clockwise direction, towards the area of "low pressure." If we now examine those blowing around the area of "high pressure" we find that the winds blow spirally outwards in a clockwise direction. These two great whirls of wind form what are known as cyclone and anticyclone.

There are two factors which control the direction of a wind:

1. The difference of pressure. This causes the air to move across the isobars from the higher to the lower pressures.

2. The rotation of the earth. This causes the original direction of the wind to be changed. In the Northern Hemishere the deflection is to the right, whilst in the Southern Hemisphere it is to the left.

13. Cyclones and Anti-cyclones Defined—

A Cyclone is a great spiral whirl of wind moving inward and upward around regions of low pressure. In the Northern Hemisphere the spiral always has an anti-clockwise direction whilst in the Southern Hemisphere they are always clockwise.

An Anticyclone is a great spiral whirl of wind moving outwards from a region of high pressure. They have a clockwise direction in the Northern Hemisphere, and an anti-clockwise one in the Southern Hemisphere.

Care must be taken not to confuse a cyclone with a tornado. The tornado is a terribly destructive storm having a narrow path. The cyclone, on the other hand, is rarely destructive and has generally a very wide path, often more than a thousand miles in width.

These great cyclonic whirls progress slowly eastward around the world in both the Northern and Southern Hemispheres. In their progress across the continents and oceans they bring about successive changes of weather. Their paths around the world

form two irregular belts, one in the Northern Hemisphere and one in the Southern Hemisphere. The southern belt includes the southern tip of South America, a small part of South-east Australia, and New Zealand.

The Northern belt crosses North America and Eurasia at the widest parts. Most of the United States and Southern Canada lie in this belt, as also does most of Europe. The principal parts of Europe not affected by them are Southern Spain, Southern Italy, and the Balkan Peninsula, as well as the region around the Caspian Sea.

These regions, it will be observed, are the lands which contain the most advanced nations. It is believed that the special type of climate caused by the weather changes of cyclonic regions are peculiarly favorable to the development of energetic races.

14. Sequence of Wind and Weather in a Cyclone. The following, quoted from an article by Sir Frederick Stupart, Director of the Dominion Meteorological Dept., in *The Canada Year Book*, 1924, entitled "The Factors Which Control Canadian Weather," will help to make clear the weather sequences of cyclones.

"The anti-cyclonic area is a disturbance in the general drift of the atmosphere, usually of enormous extent, within which the air is moving spirally outwards from the higher to the lower pressure. Within this region the weather is generally fine and settled. The cyclonic area is also a disturbance, varying from a few hundred to more than 1,500 miles in diameter. It may be elliptical or circular or very irregular in form, and within its boundaries the air is moving inwards from a higher to a lower pressure. This is the region of unsettled and stormy weather. The anticyclones and cyclones, designated as areas of high and low pressure, or more shortly as highs and lows, pass across the North American continent in constant procession from west to east at velocities averaging 20 miles in summer and 30 miles in winter.

"The highs, especially those first appearing in the more northern regions, have a tendency towards a south-eastern course, while the majority of the lows have a more directly eastward movement, the mean average track being from British Columbia to the Great Lakes and thence to Newfoundland. It is the passage of these high and low areas which brings to us the changing winds and weather, warm showery weather being associated with the lows, and fair, cool, or cold weather, according to the season, with the highs. As example: the barometer is high, say, at Ottawa and Toronto, and begins to fall as a low approaches Lake Michigan, the wind sets in from the east or south-east, cloudiness increases, and within twelve hours conditions are more or less favorable to rain. Rain falls continuously when warm, moist, expanding and hence cooling air is passing slantingly upward over a barrier of relatively cold air,

and these conditions are frequently found in advance of the low, more especially in the colder seasons, and occasionally in summer.

"But in summer it is more often that the rain partakes rather of the character of showers, perhaps with thunder, and this occurs when, with the heating of the land, upward moving, convectional, and hence rapidly cooling currents, become prevalent. It is often thought that if only water vapor in the cloud would fall as rain, it would be sufficient for all purposes, but this is not so; the actual amount of water in the cloud is not much greater than is often obtained in a heavy dew. Before an abundance of rain can be obtained, it is necessary to feed the cloud with a copious supply of water vapor. This supply is obtained when the centre or trough of lowest pressure approaches the place of observation, and the rain usually becomes heavier, and as it passes, the wind shifts to the north-west, not infrequently with a squall, and the barometer begins to rise in advance of an oncoming area of high pressure, accompanied by clearing weather. Such is an ordinary sequence of events over the larger portion of Canada."

15. Interpretation of Weather Maps and Principles of Forecasting. In order to interpret the weather maps distributed by the Dominion Meteorological Service, it is necessary to become conversant with the notation used to record the data on the map.

This can be done by consulting the legend accompanying the map. In general, solid lines drawn through the stations are the "Isobars."

Dotted lines drawn through points having the same temperature are the "Isotherms."

Heavy dotted lines are sometimes used to enclose areas where decided changes of temperature have occurred during the preceding twenty-four hours.

The direction of the wind at each station is shown by arrows flying with the wind.

The state of the weather, *i.e.*, cloudy, rather cloudy, rain, snow, etc., is indicated by special symbols which are explained in the legend of the map. A table is also appended to the map which gives details of maximum and minimum temperatures and the 24-hour temperature changes, wind velocities, and amount of precipitation for the previous 24 hours.

The text printed on the map presents forecasts for the area concerned and summarizes the general and special meteorological features that are shown by the lines, symbols, and tabulated data.

16. Principles of Forecasting from the Weather Map.

The Highs and Lows:—How they move and what they show. The general movement of lows and highs is from east to west, and they progress similarly to a series of waves, the crests of which are the "highs" and the troughs the "lows."

These alternating "highs" and "lows" have an average easterly movement of about 600 to 700 miles per day. The "lows" usually move in an easterly or north of east direction, and the "highs" in an easterly, or south of east direction. In advance of the "low" the winds are southerly or easterly, and are therefore usually warmer. When a "low" passes east of a place the wind shifts to the westerly or north-westerly with lower temperatures. The eastward advance of "lows" is almost always preceded and attended by precipitation in the form of rain or snow, and their passage is usually followed by fine weather. The temperature on a given parallel west of a "low" may be reasonably looked for on the same parallel to the east when the "lows" have passed.

What the Isotherms Show. If the isotherms run nearly east and west no decided change in temperature is likely to occur When isotherms directly west of a place incline from north-west to south-east, the temperature will rise, if they incline from north-west to south-west the temperature will fall.

The Wind Probability. If a north and south line be drawn through the middle of a "high," southerly to easterly winds will prevail to the west of it and also to the east of a similar line drawn through the middle of a "low."

Northerly to westerly winds occur west of the same line passing through the "low" and also east of the line through the "high."

If the isobars are very near together the wind velocity will be high, if far apart it will be low.

At first glance the weather map looks very confusing, but a little patience and practice soon enables one to grasp its meaning.

17. Weather Types.

Fair Weather. Absence of rain or snow. This type of forecast is often qualified by the term "generally." This simply means that the weather-man is less positive and means to indicate that the probability of fair weather over the whole district and for the entire period is not so great as when "fair" alone is used.

Partly Cloudy. Used when the indications favor clouds but no precipitation.

Threatening. Used when the weather will be overcast and gloomy with the appearance of rain or snow at any moment, yet a measurable amount is not looked for.

A forecast of rain or snow is expressed in various ways. If the single word "rain" or "snow" is used, it is expected that the precipitation will continue several hours.

Local Rain—Showers—Thunderstorms. These indicate that the conditions are favorable to the occurrence of precipitation in the district.

Clearing. Indicates that although there may be precipitation actually occurring, or expected to occur, the probability is that the end of the period will be fine.

18. Secondary Depressions. If the weather map on page 101 of *The High School Physics* be examined, it will be seen that the isobaric lines do not make very regular ellipses or circles. This distortion of the isobaric lines is due to secondary depressions. These exert very powerful influences on the weather over the area in which they are developed.

There are three of these secondary depressions which are readily recognized on the maps and which produce definite weather conditions. They are:

(1) V-Shaped Depressions. These are well shown on the weather map to which we have just referred. Notice that the isobaric lines point away from the lows in the form of a V, and that the general direction of the point of the V is southward. Now it should be quite obvious that as the lows move across the continent the weather conditions on the two sides of the V will succeed each other more rapidly than in the case of the ordinary or wide type of depression. This means that the storm will come suddenly at any place and will pass away quite as suddenly. A V-shaped depression, then, usually brings stormy weather which clears up quickly.

(2) The Wedge Isobars. In the region of the highs there is to be found a similar modification. This is called a "Wedge of high pressure." It usually points northward. Being narrower than a normal anticyclone, the wedge usually brings fine weather which only lasts a short time. Wedges may be picked out on the weather maps in Caldwell and Eikenberry's *General Science,* figs. 25 and 26, pages 40 and 41.

(3) Straight Isobars usually indicate mild and unsettled weather with south-westerly winds.

CHAPTER II.

Climate.

19. Climate may be defined as the "Average weather conditions of a region as observed over considerable intervals of time."

Care must always be taken to insist upon the difference between "Weather" and "Climate."

Weather, it will be recalled, is the daily condition of the atmosphere as regards its "temperature" and "moisture" together with the "state of the sky," and the "direction and velocity of the wind." It will, therefore, be possible to have "bad weather" in a place having a "good climate" and *vice versa.*

20. Factors Determining Climate. The chief causes that determine the climate of any place are primarily two:

(1) Latitude, that is, its position north or south of the equator.

(2) Altitude, or height of a place above sea level.

Besides these two main controllers of climate are seven local "modifiers" of climate; these are:

(1) The distribution of land and water areas.
(2) The presence and direction of mountain chains.
(3) The presence of ocean currents.
(4) The presence of large forests.
(5) The direction of the slope of the land.
(6) The direction of the prevailing winds.
(7) The position on the east or west side of a continent.

21. How These Controllers and Local Modifiers Affect the Climate of a Region. In defining weather, we stated that it was the condition of the atmosphere as to temperature, pressure, wind, moisture, cloud, etc. All these conditions are primarily dependent on the temperature. Therefore whatever will modify temperatures will produce a change in the weather and so affect the climate of a place.

We must, therefore, in studying these factors, always keep in mind their effects upon temperature, and we shall immediately be able to see what effect they will have in modifying climate.

Latitude chiefly affects temperature by determining the angle at which the sun's rays strike the earth. Places within the

tropics, and therefore near the equator, receive the sun's rays more vertically than places nearer the poles. In other words, the total quantity of heat received per square yard diminishes as the latitude increases and hence—

22. The Mean Temperature of the Air, Which is the Main Element of Climate, Diminishes With Increase of Latitude.

If the earth were entirely covered with water, or if it were entirely land of uniform height, latitude alone would regulate temperature and other atmospheric conditions; but the unequal distribution of land and water brings into action, as modifiers of this condition, the different properties of land and water, the effects of ocean currents, of warm and cold water and the effects of prevailing winds.

Latitude has the effect of producing three distinct horizontal climatic belts on each side of the equator, viz.:

(1) *A Hot Belt,* where if the rainfall is sufficient, human wants are few and easily supplied, and the people are indolent and unprogressive. If rainfall is scanty, life is almost impossible except where the energetic people of the temperate zone have intervened and overcome this deficiency by irrigation.

(2) *A Cold Belt.* Here the conditions of life are so difficult and discouraging, and in which most must be made of the long, light, summer days to secure supplies of food and clothing against the long, dark and cold winter. This struggle to live leaves little or no time for higher development.

(3) *Temperate Zone.* This lies between the other two; here man and nature working together have produced in the Northern Hemisphere the highest types of civilization. In the Southern Hemisphere, this belt is nearly all ocean, and so has not land area enough to ever allow it to become so potent as the northern zone.

23. Altitude. Variations of altitude lead to what may be called vertical climate zones. The effect of altitude is always to reduce the temperature. The average reduction is about 1 degree Fahrenheit for every 300 feet of ascent. Consequently in the temperate zones, mountains and table lands are bleak and almost uninhabitable, but in the tropics such regions are healthy and capable of considerable development by Europeans, *e.g.*: It is the great table-land of Africa, extending from Abyssinia in the north to Cape Colony in the south and nearer to the east than the west coast, which supports her most vigorous and aggressive native populations, viz., the Bantu-speaking negroes like the Zulus, Basutos, Matebeles, Swazis, Mashonas, Bechuanas, Masai, etc. These peoples are somewhat picturesquely referred to as the "Dwellers on the Plateau" by the other races in Africa. Here on the plateau have already commenced

the European settlements of Rhodesia, Kenya Colony, and Uganda, where Europeans are finding a fine, grassy, well watered upland with a splendid climate, although it straddles the equator.

24. The Distribution of Land and Water Areas. Land heats rapidly in the sunshine and so readily attains a high temperature during the day time or in summer. In the absence of sunshine it loses this acquired heat just as readily as it gained it. Therefore, there is considerable difference between day and night, and between summer and winter temperatures over land areas.

Water, on the other hand, heats and cools slowly and so it does not have nearly so marked differences of temperature as the land displays. Because of this the atmosphere overlying large water areas is not subject to such great variations of temperature.

Consequently regions near the sea coast are characterized by less marked changes in temperature than localities which are in the interior of a continent, where great and sudden changes in temperature with long, cold winters and short, very hot summers are more common.

These two types of climate are so distinct from each other that they are named Oceanic or Insular in the first case, and Continental in the second case.

The Great Central Plain of North America has a typical continental type of climate, whilst Nova Scotia and British Columbia, and the British Isles, may be said to be typical of the Oceanic type of climate.

25. The Direction of the Slope of the Land. This affects temperature, since that slope which receives the sun's rays in a direction most nearly at right angles to the surface will be warmest.

In the Northern Hemisphere the southern slopes and in the Southern Hemisphere the northern slopes are usually warmest.

The Presence and Direction of Mountain Ranges. The mountain range exerts other influences on climate than the mere effect of altitude.

It may affect the temperature of a region by being so placed as to shelter it from either cold or warm winds. Again it may be so placed with regard to the direction of the moisture-laden winds as to cause a heavy rainfall on one side of its slopes and a scanty one on the other.

26. The Presence of Large Forests, or, indeed, the nature of the covering at all, will affect the temperature of a region. When covered by dense vegetation, such as forests, or when wet and marshy, it heats and cools less rapidly than when vegetation is scanty, or the heat very dry, as in deserts. This

accounts for the extremes of temperature between night and day in desert regions. Desert nights are always very cold and the days very hot.

27. The Direction of the Wind. Winds are the great transporters of climate. The direction of the winds and their condition as to humidity so greatly influence the temperature of the countries over which they blow that it is impossible to interpret the climatic conditions of a region without a proper understanding of the wind belts of the earth. We will, therefore, consider the origin and the distribution of the winds.

Read carefully pages 190 to the beginning of the section on weather and climate on page 209 in *The High School Physical Geography* and study thoroughly the two diagrams showing—

(*a*) The wind systems of the world;

(*b*) Diagram showing the general movement of the atmosphere.

From this study you should now be in possession of the following facts:

(1) Winds are horizontal movements of the atmosphere.

(2) Calms may be produced by the air being still, or either rising or falling.

(3) If the air is rising, we have low pressure calms, and if it is falling we have high pressure calms.

(4) Surrounding the earth is a belt which has the highest average temperature: this is called the Heat or Thermal Equator. It does not coincide with the geographical equator.

(5) The heat equator is migratory, moving southward during our winter, and northward during our summer, but for the most part always north of the geographical equator. This is especially the case when crossing large areas of land.

(6) Since this zone is the location of the highest earth temperatures, it follows that the atmosphere above it must have the highest mean temperature and is, therefore, lighter over this belt than at any other points on the globe. It, therefore, rises, producing a belt of calms of low pressure called the "Doldrums." As it rises it becomes chilled and its moisture-holding capacity is thereby diminished. This results in saturation and the region is characterized by midday clouds and daily rains. This region extends about 10 degrees north and south of the true equator of the earth.

(7) To either side of this belt there is a belt of steady winds caused by air rushing in to take the place of the rising air. These are called the "Trade Winds" belts. They are remarkable for their constancy of direction and steadiness of pressure. The region of the Trade Winds is roughly from 10° to 25° north and south

latitude. They blow from the north-east in the Northern Hemisphere and from the south-east in the Southern Hemisphere.

(8) Beyond the Trade Winds belts in each hemisphere is a narrow belt of *high pressure* calms caused by the descending column of air which has risen over the Doldrums region, but has now cooled and become therefore denser. It could not fall directly down over the heat equator because the horizontal movement of the trade winds buoyed it up. These belts of high pressure calms are called "Horse Latitudes" by sailors.

(9) Between latitudes 40° and 50° in each hemisphere is a belt of winds. These winds are known by various names, such as the Prevailing Westerlies, Anti-trade Winds, Cyclonic Winds. They circle round the globe in a west-south-westerly direction in the Northern Hemisphere and a west-north-westerly direction in the Southern Hemisphere. They exist in the larger part of the temperate zones, and so blow over the regions occupied by the chief nations of the world. They are often interrupted by cyclonic storms. To these interruptions are attributed the variations in the daily weather so characteristic of these regions, and which according to meteorologists are responsible for the vigor and healthiness of the peoples inhabiting the temperate zones. In the Southern Hemisphere, you will see that there is scarcely any land mass to impede their progress round the world, Tasmania, South Island of New Zealand, and South America, south of Bahia Blanca in the Argentine being the only land south of latitude 40°. Here they attain great force and blow with remarkable constancy. In this region we find more sailing vessels than in any other part of the world. Sailors term this region "The Roaring Forties."

(10) Beyond these westerly winds there are in each hemisphere the Polar Winds. Little is known about them.

(11) The winds described above are known as "Planetary Winds."

(12) Besides these Planetary Winds, we find in the Indian Ocean the "Monsoon." Monsoons are seasonal winds. They are caused by the shifting of the heat equator. In summer the heat equator lies mostly over the land in this region. In winter it follows the sun southwards, and so passes into the water. Monsoon lands, therefore, have hot, wet summers and cool, dry winters. They have tremendous effect upon the rainfall and climate of India and Abyssinia.

In India it is the wet monsoon which gives to Southern India its wonderful crops and causes the terrific rainfall in Assam and Nepal, viz.: 480 inches of rain per annum. The severity of the rainy season in these

places may be judged when it is stated that the whole 480 inches of rain falls in roughly six months of the year.

In Abyssinia the monsoon is responsible for the annual inundation of the Blue Nile, which in turn causes the annual flooding of the Nile, and so gives Egypt her magnificently fertile land and great crops, although Egypt is a rainless land.

Monsoons are also developed, but on a lesser scale, in the Gulf of Guinea, the Caribbean Sea, the Gulf of Panama, and Northern Australia.

(13) A seasonal wind is formed along the east coast of Canada. Cold winds blowing from the continent in winter, and from the sea to the continent in summer.

(14) There are also several types of daily winds, such as land and sea breezes, mountain winds.

(15) Cyclones are the most important local winds. These are spiral whirls in which the wind moves inward and upward around regions of low barometric pressure. They produce varying winds, clouds, and rains in the districts over which they pass. By means of these cyclones even the eastern sides of countries in the west wind belts get considerable rainfall, and so in these regions we find nothing to compare with the deserts of the Trade Wind regions.

In the study of climate we must always remember the following principles regarding wind:

(1) Warm air can hold more water vapor than cold air.

(2) If a wind is saturated and rising, or if it is passing from a warmer to a cooler region, it will bring rain to a country.

(3) If falling (for example, blowing down a mountain slope), it becomes compressed and therefore warmer, and will then absorb moisture from the land. These are drying winds. The Chinook of Alberta belongs to this class of wind.

(4) Winds passing from a cooler to a warmer region are having their moisture-holding capacity increased. They, therefore, pick up moisture and tend to make the land arid.

(5) Winds in conjunction with favorably-placed mountain ranges are bringers of rain.

(6) Winds which have passed over large areas of land are usually unsaturated and tend to pick up moisture.

(7) Winds which have passed over large bodies of water are usually saturated and if forced to rise, or are otherwise cooled, will produce rain.

28. Position of the East or West Side of a Continent. This advantage is conditional on the wind belt in which the

region is situated. In cyclonic regions the west side has the more favorable climate, because the winds reaching it have passed over warm ocean currents before reaching it. In the Trade Wind regions the east side of a continent is best, and for the same reason.

29. Ocean Currents. These greatly influence the temperature of the countries near whose shores they pass, if the prevailing wind be shoreward. Otherwise their effect is very small. The effect, of course, is conditional upon the temperature of the current.

30. Division of the Earth into Climatic Zones. Zones of climate are areas in which similar weather conditions prevail. There are four factors which cause the main differences between these climatic zones. These are:

(1) Latitude.
(2) Temperature.
(3) Wind systems.
(4) The topography of the land.

The climatic zones of the earth are not identical with the zones of temperature, wind zones, or rainfall belts, but are the results of a combination of all the factors controlling climate which have just been discussed.

Of the factors enumerated above, the third gives us perhaps the best starting point for divisions of the earth into climatic zones.

In the discussion on "The Direction of the wind," sec. 27, pars. 6, 7, 8, 9, and 12, we saw that the earth might be divided into a series of wind or pressure belts, viz.:

(1) A belt of equatorial calms.
(2) Two belts of trade winds.
(3) Two belts of high pressure calms.
(4) Two temperate or cyclonic belts.
(5) Two polar belts.

These wind belts give us the following climatic zones:

(*a*) Tropical Zone. (Equatorial calms and N.E. and S.E. trade wind belts.)
(*b*) Sub-Tropical Zones. (Northern and southern high pressure belts.)
(*c*) Temperate Zones. (North and south-west wind belts.)
(*d*) Circumpolar Regions. (Polar wind belts.)
(*e*) Monsoon Regions. (Of South-eastern and Eastern Asia and Northern Australia. This corresponds to the Indian Ocean Monsoon belt.)

31. The Tropical Zone. This zone is divided into two principal regions, viz.:

(*a*) The Equatorial Zone.
(*b*) The Trade Wind Zone.

The equatorial zone is a belt about 30 degrees wide, characterized by the low atmospheric pressure, by calms and by abundant rain. The temperature is always warm, averaging over 70° Fahrenheit.

The annual mean isotherm of 85° Fahrenheit is included in this belt. The annual variation in temperature is small, usually under 10 degrees, and in some places less than 5 degrees. There is no summer or winter, but there are four alterations of wet and dry seasons each year—

(1) A dry season when the sun is in the south.

(2) A wet season when the sun crosses the equator going northwards.

(3) A dry season when the sun is in the north.

(4) A wet season when the sun crosses the equator on its return south.

The life of plants and animals is controlled almost solely by these factors.

This belt contains many of the very heavy rainfall regions of the world; it is estimated to have an average of about 100 inches of rain annually.

Vegetation is luxuriant, so much so that man has not been able to subdue it.

32. The Trade Wind Zones. In the regions occupied by the trade wind zones both north and south of the equator the sky is bright, the air fresh, and there is no marked change of seasons. The winds blow constantly and regularly with a fairly uniform velocity from about latitude 28° north and south of the equator; their influence is, however, felt as far as latitude 40°. Both the north-east and south-east trade winds passing from a cooler to a warmer region become warmer as they near the equatorial zone. They, therefore, are enabled not only to hold their water vapor, but also to take up moisture from the land and sea over which they pass. If these winds pass over highlands they become cooled and this moisture falls as rain. Thus the Trade Wind Zones are characterized by extensive desert regions and regions of very heavy rainfall.

With the annual journey of the sun across the tropics the whole system of wind belts is shifted north or south of the equator and these trade wind belts are carried with it, and so rainy and dry seasons are accordingly given to districts outside the tropics. To sum up, the trade wind zones are characterized by fair weather, steady winds, and slight annual changes of temperature. Rainfall at sea level is either very infrequent or absent. The lowlands of the regions are deserts, and the highlands which lie in the paths of the winds are subject to heavy rain. Over the ocean, trade climates are the most uniform known.

33. The Sub-Tropical Regions. These are transition zones of high pressure lying between the Trade Zone Winds and the

Temperate Zones. They are characterized by calms and variable winds. The annual shift of the wind belts brings this region alternately under the influence of the Trade Winds and the Westerlies. They are, however, too far from the equator to receive excessive rain and are just out of reach of the storms of the Westerlies. They, therefore, have an unique and agreeable climate. The rains are winter rains, but are not excessive, and the summer has continuously fine weather.

They are noted health resorts; they include Southern California, part of Chile and Argentina, the Cape of Good Hope, Western Australia and practically all of the Mediterranean shores of Europe and Africa.

This latter fact gives its name to this particular type of climate, viz., the "Mediterranean Climate."

34. The Temperate Zones. Owing to the great differences in the comparative areas of land and water in these zones, they must be considered separately, for they have very great differences in climatic characteristics.

35. The South Temperate Zone. This lies between the southern horse latitudes and the South Polar Region. It is a region of very uniform climatic conditions. This is due to the fact that it is almost entirely a zone of water. Summer and winter are only moderately developed and extremes of any kind are rare throughout the zone. The prevailing winds are the Westerlies. A cloudy sky is common. The smaller islands of the zone have cool summers with colder winters, giving a monotonous and unattractive climate. South Georgia is in the corresponding latitude to England, but its climate is a singularly inhospitable one.

36. The North Temperate Zone. This zone lies to the north of the northern horse latitudes. It contains more land than water. It is the very opposite in this respect to the South Temperate Zone. The name "Temperate" is particularly inappropriate to this zone, for it is a zone of the most marked extremes of winds, rainfall, temperature and variety of climatic details.

The prevailing winds of the zone are the "Stormy Westerlies." These winds are far less regular than either the Trades or the Westerlies of the South Temperate Zone, and are much more interrupted by cyclonic storms. The rainfall over a large part of the zone is from 20 to 80 inches, and its distribution is controlled by cyclones and topography.

The differences in temperature between the hottest and coldest months reach 120 degrees in Siberia and 80 degrees in North America. Many of the coldest and some of the warmest lands on the globe are contained within this zone.

It is the only zone which has a division of the year into four well marked seasons based on the differences of temperature,

viz.: Spring, Summer, Autumn, and Winter. This fact has an important bearing on the development and adjustment of plant and animal life.

This region also contains the most active and civilized nations. The most eminent geographers are unanimous in the opinion that there seems to be a direct relation between this four-season type of climate and the presence of the great civilized races of the world. No other climatic zone has so complex a distribution of temperature, sunshine and rainfall; and in consequence the variety of plants, animals, and men transcends that of any other part of the earth.

37. The Polar Climatic Zones. These are climates of extreme and prolonged cold. The ground is covered with snow for the greater part of the year. During the winter the sun never rises above the horizon, whilst during the summer it never sets. There are only two seasons, summer and winter, and the change from one to the other is very abrupt. There is no warm season and daily weather changes are almost unknown. The climate is especially unfavorable for both plants and animals.

38. The Monsoon Regions. Monsoon climates are distinguished from all the others by the following features:

(1) They are all within the tropics.
(2) Winds blow from sea to land in the summer, which is, therefore, the wet season.
(3) Winds blow from the land on to the sea in the winter, which is, therefore, their dry season.
(4) There are only two seasons in the year, the wet and the dry.

The following are the monsoon regions of the world:

In Asia—Burma, Siam, Indo-China, Southern China, Philippine Islands and India, excepting the North-west.

In Australia—Queensland and the Northern Territory Coast lands.

In Africa—Part of Abyssinia, the Central East African Coast lands and Madagascar.

In America—Central America, the Caribbean Sea-board, the West Indies and a portion of the Brazilian Sea-coast.

The most perfect development of the monsoon type of climate is found in Southern and Eastern Asia. The most important fact about monsoons is the summer on-shore winds with their accompanying heavy rainfall. The effect of these rains is wonderful, for they come at the season when they are of most benefit to the crops.

Nearly one-half the world's population lives in the Monsoon lands and the majority of them are engaged in agriculture. These regions are very unsuited to settlement by Europeans,

owing to the prevalence of tropical diseases like malaria and other fevers. They are, however, capable of settlement and cultivation by such peoples as the Hindus, Chinese, Japanese, Malays, etc. The natural and cultivated vegetable products of the Monsoon regions are extremely varied; in fact, no one of the other regions of the world can show such an abundance of valuable vegetable products. The leading ones are palms, bamboos, hardwoods, rice, corn, sugar, and cotton. The Australian Government, in carrying out its policy of an "all-white" Australia, is conducting an experiment along its Monsoon lands, by shutting them off from colonization by the Asiatic races to the north of them. This attempt to develop a Monsoon region by European colonization is being watched with great interest, because every other previous attempt has proven a disastrous failure.

39. Subdivisions of Zones Upon Basis of Topography. The topography, or shape of the surface of the earth, exerts great modifying influences upon the climate within the major zones, producing very distinct secondary climatic regions. For a very full discussion of these effects, and a complete list of the regions, an advanced text-book in geography must be consulted. For the purpose of this manual we may consider a few of the most important, viz.:—

The Interior Lowlands.
The Interior Highlands.
The Continental Margins.
The Deserts.

40. The Climates of the Interior Lowlands.

(*a*) Interior lowlands in *cool temperate zones* produce the Siberian type of climate.

Location—In Eurasia they include the Central Lowlands, Poland, European Russia (except the south), and Western Siberia, with Alpine lands and parts of Germany and Sweden. In North America, the northern prairie land.

Characteristics are: Extreme climate, hot summer, long, hard winters. Rainfall mostly in summer, nowhere heavy, and quite small towards the east of the region in Eurasia and the west of the corresponding region in North America.

(*b*) Interior lowlands in *warm temperate zones* have what is called the Turanian type of climate.

Location—In Eurasia: Turan, Trans-Caspian and Caspian districts, South Russia, Danubian plains and part of Manchuria. In North America: The West Central States. In South America: Northern Argentina. In Australia: Interior parts of New South Wales, Victoria, south part of South Australia.

Characteristics are extreme climate and scanty rainfall due to interior position. Typical features are the extent of lands available for stock-raising, and the necessity for irrigation if agriculture is to be developed.

41. Climates of the Interior Highlands. These are divided into two types—

(1) Interior highlands of the *cool temperate zone.*

(2) High plateaus.

The Interior Highlands of the cool temperate zones give the Altai type of climate.

Location—In Asia: Altai and the adjacent plateau lands. In North America: The northern part of Western Cordillera region, viz.: British Columbia, and the north-west States of the United States.

The high plateaus give the Thibet type of climate.

Location—In Asia: Thibet and the adjacent mountain lands. In South America: Andean high plateaus and mountain lands in Peru, Bolivia, Chile, etc.

Characteristics—In Asia the rainfall decreases from north to south, so that the northern slopes have more rain and are more densely forested than the southern slopes. In America the rainfall decreases from west to east and the western slopes of all the parallel ranges are much wetter than the eastern. Therefore the western slopes have the denser forests.

Elevation is the controlling climatic factor in these regions, but the climatic conditions vary very greatly with the local variations of altitude, slope and shelter. The North American region is the more fully developed region, supporting important lumbering, mining, grazing, and agricultural occupations. The Siberian highlands are capable of similar development. Here the principal occupation is hunting and trapping, but mining is attaining some importance.

42. The Interior Highlands of the Warm Temperate Zones. These result in two types of regions, viz.:

(*a*) Plateau or Iran type.

(*b*) Plateau with cold winters or Mongolian type.

Iran Type Location—In Asia: Iran, that is the interior of South-Western Asia, viz.: Persia, Beluchistan, etc. In America: Arid lands of the South-Western States and Mexico. In South Africa: The Veldt of the Orange Free State and the Transvaal.

Characteristics—The climate is extreme and dry. This feature is more pronounced in the American and Asiatic region than the South African region because the latter region is not enclosed by such high marginal mountain ranges.

Fertility is only attained by irrigation or in favored valleys. The natural vegetation is rich grassland, poor grassland or scrub according to the rainfall. They support great herds of cattle, horses, and flocks of sheep and merino goats. In South Africa because of the rainfall the richer parts are cultivated to cereals.

Plateau With Cold Winters—Only found in Asia, viz.: Mongolia and adjacent lands. The higher elevation of these

plateaus, compared with the previous regions gives a cooler summer and much colder winters. The other conditions are no more favorable than the previous regions. There is no exact parallel to this type of region anywhere else in the world.

43. The Continental Margins. These fall into four groups, viz.:

The Cool Temperate Eastern Margins.
The Cool Temperate Western Margins.
The Warm Temperate Eastern Margins.
The Warm Temperate Western Margins.

Cool Temperate Western Margins, or West European type.

Location—In Europe: British Isles, S. W. Scandinavia, Denmark, Western Germany, Holland, Belgium, France (except the Mediterranean slope), and Northern Spain. In North and South America: The Pacific seaboard of Canada and the North-Western States, Southern Chile. In Australasia: Tasmania, South Island of New Zealand.

All the regions of this type are subject to the influence of the ocean from the West. In consequence, the climate is never extreme. Rainfall occurs at all seasons, but especially in the autumn and winter. It is generally ample, but becomes heavy where the mountains face the sea. Great expanses of forest are characteristic. It must, however, be remembered that in Europe these have been largely cleared away. The deeply indented coasts of these regions and presence of continental shelves due to the submergence of the coast makes them regions especially favorable to the development of the fishing industries.

Cool Temperate Eastern Margins, or St. Lawrence type.

Location—In Asia: Armenia, Eastern Korea, Northern Japan. North America: St. Lawrence Basin and Newfoundland, and North-East United States. South America: Southern Argentina.

Characteristics—The winters are colder, and the rainfall smaller than in the western marginal lands. Summer is the season of most rain, although rain falls at all seasons.

The greater cold of the Eastern Margins is clearly demonstrated by the freezing of the rivers and harbours except of the Southern Margins, *e.g.,* the St. Lawrence ports and the harbours of Vladivostock are frozen for several months of the year, whilst the ports of Halifax and Port Arthur are never frozen.

Warm Temperate Western Margins, or Mediterranean type.

Location—In Europe, Asia and North Africa: The Mediterranean Coast lands, including most of Spain, with Portugal, Southern France, Italy, Jugo-Slavia, Balkan Countries, Coast lands of Asia Minor, Syria, and North Africa. In North and South America: California and Northern Chile. In South

Africa: The South-Western extremity (the Cape of Good Hope). In Australasia: The South-West of Western Australia, the south of South Australia, and the North Island of New Zealand.

Characteristics are warm summers, mild winters and winter rains. The natural conditions as a rule are very attractive to human settlement. The cultivated fruits of these regions are very important. They are chiefly olives, mulberries, grapes, oranges, lemons, figs, and apricots. Wheat, corn, rice, tobacco, and cotton are also grown. The industrial life of the people is based upon these products, *e.g.*, soap-making depends on the olive (Marseilles being the great soap centre of the world). Silk manufacturing depends upon the mulberry (consider Lyons and Northern Italy). Wine-making from grapes, as well as fruit-packing and canning industries, depends upon the splendid fruits of these regions.

Warm Temperate Eastern Margins, or China type.

Location—In Asia: China, Western Korea, and Southern Japan. In North America: The United States, viz., Iowa, Missouri, Arkansas, Eastern Texas, and East thereof to the Atlantic and Gulf Coast. In South America: South-Eastern Brazil. In Africa: The South-Eastern coast lands. In Australia: The seaboard of New South Wales and Southern Queensland.

Characteristics—The summer is hot and is the principal rainy season. Winters are as a rule cool to cold.

Local modifications—In Southern Japan the insular condition causes a fairly uniform rainfall throughout the year, and in the Australian and South-East African region the winters are mild. The occurrence of the heaviest rains in the summer season ensures an abundant vegetation. Prior to the clearing of the lands in some of these regions, most of them were covered with such broad-leaved trees as oak, beech, walnut, and magnolia. In cultivated plants a wide range is found making these regions some of the greatest agricultural areas of the world.

Cotton, sugar, rice, tobacco are the chief crops in the South-Eastern United States, while tea and mulberry, with the silk-worm culture, are additionally important in China and Japan.

44. The Desert Regions of the Earth. The study of a rainfall map of the world will show that deserts are not distributed over the earth in a haphazard way, but that they lie in the track of the trade winds, or else they are in the lee of mountain ranges. Therefore there are two types of deserts—

(1) Trade Wind Deserts.

(2) Deserts on the leeward side of mountains.

Trade Wind Deserts—These are the Sahara type of desert.

Location—In Northern Africa: Sahara, Libya, Somaliland. In Asia: Arabita, Syria, and North-West India (Thar Desert). In North America: South-West North America (Mojave and Gila Deserts). In South America: The central Pacific coast lands in Northern Chile and Southern Peru. In South Africa: The Kalahari and Namaqualand Deserts. In Australia: West Central Australia.

The North-East Trades cause the deserts of Arabia, Syria, Thar, and Sahara and those of Lower California. The South-East Trades produce the desert areas of West Central Australia, Kalahari, and Namaqua deserts of South Africa and the Atacama desert of Chile and Peru.

Characteristics—The bare surface rapidly heating and cooling causes a great range of temperature between day and night, and between winter and summer. Scattered over these desert areas are numerous oases, which are not the paradises of fiction, but merely regions where conditions are relatively more favorable. Even in these oases the water supply is limited and often not very palatable.

Sand storms are great deterrents to life in the desert, be it plant or animal.

The plants are curiously adapted by long roots, thick bark, thorns and poisonous juices to the arduous conditions under which they live.

The animals have also developed structures which assist in conquering their environment, e.g., the stomach of the camel which enables it to carry an extra amount of water, its remarkable hump which is really a storehouse of food, the curious feet which enable it to walk on the sand, as well as the closing nostril which enables this remarkable animal to resist the sand storms.

Deserts on the leeward side of mountains—Any inclosed basin is more or less arid, e.g., Bohemia, the Plain of Hungary and the great Po Valley.

Again, if besides being bordered by mountains the inclosed area is at a considerable elevation, precipitation is greatly decreased. Thus the West coast of British Columbia at Vancouver is plentifully supplied with rain, whilst South-Eastern Alberta is a "Dry Area" with less than 15 inches rain annually. This is the cause of the great Gobi Desert and the other deserts of Central Asia.

The characteristics of the leeside of the mountain deserts are very similar to those of the trade wind deserts.

A very instructive and useful map to make is one which shows quite clearly the location of these great desert belts over the earth. It should also be remembered that besides these hot deserts there are also the cold deserts, which are the icy regions of the earth.

A fact which is not often noted is that one-fifth of the earth's surface is desert.

45. Influence of Climate on Human Activities. No other circumstance of man's environment influences his activities so profoundly as does climate.

It is absolutely the most important of all the physical conditions affecting man. Climate affects the activities of man in three principal ways—

(1) It limits his movements.

(2) It determines the nature of his food, clothing, and shelter.

(3) It very directly affects his health and energy.

46. Limitation of Man's Movements by Climatic Barriers. The principal climatic barriers to man's movements are—

(1) Fogs, winds, and icebergs on the ocean.

(2) Low temperatures, wind, and rarefied atmosphere in mountains.

(3) Lack of rainfall, sand storms and sand dunes, together with high temperatures in the deserts.

(4) Damp heat in tropical forest regions.

(5) Low temperatures, fields of snow and ice, and permanently frozen subsoil in polar regions.

Climatic Barriers to Man's Movements on the Ocean:

(*a*) Everyone knows how fogs hamper and make extremely dangerous the movements of shipping across the oceans. Every year they take toll of human lives and wrecked ships with their consequent losses in wealth. They also cause the spending of large sums of money in an attempt to lessen the dangers of navigation during foggy weather. Of all climatic conditions of the seas the fog is the most dreaded by mariners.

Gales often prevent ships from putting to sea at appointed times, and also delay the arrival of others. Sometimes gales of great fury exact a great price in wrecks, and damage to ships and cargo.

Icebergs are in some seas a constant menace to the shipping in those waters. The loss of the Titanic, which struck an iceberg in the North Atlantic and sank with 1,500 people is an instance of how puny man's handiwork really is when pitted against one of these "terrors of the seas."

It is the combined presence of icebergs and fogs which strictly limits the use of Canada's great inland sea, the Hudson Bay, as a great transportation route to and from the grain fields of the prairies.

(*b*) The low temperatures, cold biting winds, avalanches, snow storms and glaciers, together with the thinness of the atmosphere are more real barriers to man's movements in the mountains than are mere facts of relief.

These climatic conditions restrict the growth of vegetation to such an extent that food supply for beasts of burden and man

himself is very limited. The terrible storms, and the cold air of the nights, together with the avalanches and crevasses of the glaciers cause annually a dreadful loss among the animals used for transport in these regions.

In the case of railroads these conditions are constantly delaying trains, and often causing wrecks notwithstanding the immense sums spent in the erection of snow sheds, driving of tunnels and operating snow ploughs in order to maintain an open way.

Even in the aerial navigation of the future, the uncertainty of the weather above mountain ranges, together with the thinness of the air at great altitudes, will always make mountain barriers dreaded by aviators.

(*c*) Lack of rainfall, sand storms and sand dunes, together with high temperatures in the hot deserts are really so well known that little need be said of them.

Everyone is familiar with the lack of water in these deserts, and how man is forced to rely on the camel as a beast of burden. But perhaps an even greater difficulty than the water supply question in a desert is the presence of sand dunes. These sand dunes are a direct result of climatic conditions. In many places they are piled up hundreds of feet high. The difficulty of traversing these hills of dry, sliding sand is so great that no one can venture far into the areas where they are abundant.

Then again, another limiting factor is the fact that these dunes are constantly shifting. During their progression over the country they eliminate all land marks. Besides the dunes, the wind is constantly lifting the dry dust in huge stifling, choking clouds, making the dreaded sand storms of the desert. The effectiveness of the limitation which a hot desert places upon man's activities is shown by the fact that in Southern Arabia there is a region many hundreds of thousands of square miles in extent which no explorer has ever penetrated.

47. Damp Heat in Tropical Forest Regions. This combination of heat and moisture in the tropical regions produces an environment peculiarly suited to the growth of dense forests. The abundant moisture is also favorable to the propagation of the most deadly forms of tropical fevers, such as malaria, yellow fever, blackwater fever, and the like.

The general effect of the hot-house-like temperature of these regions is terribly exhausting. The result is that these regions are almost impassable barriers to the movements of man. In the tropical forests of Brazil the making of roads is almost impossible, because the rapidity of the growth of the jungle is sufficient to close up the road again within a month or two. The only means of travel in such countries are along the rivers, and these are so fever-stricken that only a few miserable natives can live there.

48. Low Temperatures. Fields of ice and snow and a permanently frozen subsoil effectively limit man's movements in the Arctic and Antarctic regions. These frigid caps of our globe present the most formidable barriers known to man.

The largest areas of unexplored land are still the icy plateaus of Antarctica, and Greenland, and the bitterly cold regions of Northern America and Asia. The story of the search for the North-West and the North-East passages to India is one of the most enthralling stories in the history of exploration. At a terrible cost in lives and money the passages were found, but we cannot use them, the climatic conditions forbid it. It is the same story with regard to Antarctica. Around the South Pole, buried under a mantle of snow and ice, there lies a continent nearly twice the size of Canada. No vegetation save a few mosses and lichens exists anywhere on this vast expanse. No four-footed animals or human beings rove over its icy fastnesses. Hundreds of thousands of miles of pack ice, glaciers and ice walls guard it on all sides from the penetration of plant and animal life. Man has travelled across it. He has sailed around it. He has paid tribute of gallant and heroic lives in plenty, and the icy barrier remains unchallenged.

49. Relation of Climate to the Nature of Human Food, Clothing and Shelter.

Relation of climate to the nature of food supply—

There are two principal factors governing the food supply, viz., the soil, and the climate. Of these the climate is by far the more important. This is so for several reasons, the principal being that although we may improve the soil by tillage, rotation of crops and the addition of fertilizer, we are absolutely unable to exert any control over the climate.

For example, the soil of the Prairie Provinces of Canada is just as fertile as that of the corn belt, or the cotton belt of the United States, and forms part of the same great physical feature, viz., the Great Interior Plain. Yet the prevalence or absence of early or late frosts determines where we shall stop planting cotton trees or corn, whilst the seasonal distribution of the rainfall determines just where the wheat zone may lie, and where the hardy cereal crops like oats and barley replace wheat as the principal crop.

Every one knows, at least vaguely, that food varies with the climate, but few realize how inexorably this is so. Three examples of widely varying types will indicate how this idea may be further worked out as class projects.

The modern study of dietetics has shown that a good diet must contain three main elements and that these must be present in due proportion, viz.:

Carbohydrates, which produce energy.

Fats, to give body heat, also energy.

Proteins, whose function it is to repair body waste and to build new tissue.

In addition, small quantities of mineral salts, vitamines, and fruit acids are required.

Example A. The Eskimo Diet—

The Eskimo may be taken as a typical Frigid Zone inhabitant. Here, the climate being cold, and fuel scarce, the people require very large quantities of fat, so seal or whale blubber or fat forms one of the principal articles of diet and is eaten by them out of all proportion to all other staples. The ravenous eating of tallow candles by Eskimo children is well attested. Owing to their location and the scarcity of land animals, many Eskimo groups are forced to live for long periods on nothing but protein. At such periods they eat and eat, but are not satisfied. Their bodies crave carbohydrates, but the ground is frozen so long that cereals, vegetables or fruits cannot be obtained. In the very short summer the berries of the tender plants are eagerly gathered and eaten, but the relief is only temporary. The Eskimo, therefore, suffers from intestinal diseases, malnutrition, and scurvy and his resistance to disease is very greatly lowered.

Example B. The Diet of the Rain Forest Peoples—

Here we have the opposite extreme of an unbalanced diet. The animal life is so crowded out by the luxuriance of the vegetation that its principal representatives are birds, reptiles, and insects. The staple article of food is fruit, of which they eat the same kinds for weeks on end according as the season lasts, and although they gorge themselves they cannot obtain enough protein because, for instance, if bananas were the principal food supply, as it is in many of these parts, it would require from seventy to eighty bananas per day for each person. Just fancy having to eat from thirty to thirty-five bananas, and nothing else, for a meal. This in time ruins their digestion. Another objection, besides the poor quality, is that food of this kind is so plentiful that the people of such regions do not eat regularly but stuff themselves to the sickening point and then go hungry for days before they will face another meal.

Example C. The Diet in Monsoon Regions—

The principal monsoon regions of the world are China, India, Caribbean Archipelago, and the Gulf of Guinea. All these regions are great rice or millet-producing countries and in China and India they are very densely populated. Wheat or oats cannot be grown successfully there. The tremendous density of the population, 176 to the square mile in India, and 272 to the square mile in China, prevents the raising of the larger domestic meat-producing animals. This means that the common diet of the people is a starchy food, which means an excess of carbohydrates and the major portion of the land must be given over to the production of rice or millet crops. The Chinese have thus developed into a great agricultural nation, and owing to their

incessant and unsatisfied craving for protein, have developed vegetable protein production to an extent not reached by any other nation. Again, this craving for protein and the presence of such magnificent rivers in this country has led them to become great river fishermen, and probably no other nation makes such a specialty of raising fish in ponds, for fish is a form of protein that can be obtained without diverting the land from crops needed by man.

The varied animal diet of the Chinese, viz., rats, dogs, Beche de mer, bird's-nest soup, etc., materials which we despise as food, is practically forced upon them by their conditions. Their principal protein recourse is, however, the leguminous plants, which they raise in enormous quantities, especially beans. To render them palatable, and to vary the monotony, they manufacture them into bean flour, bean macaroni, bean curd, bean oil, pickled beans, etc., etc. They thus reduce the disparity between carbohydrates and proteins, but still their diet is lop-sided, far too starchy. This results in a clogging of the energies of the people. Although they are a most industrious race, they cannot be considered very energetic.

Relation of Climate to Clothing and Shelter—

This is a very direct relationship. It must be perfectly obvious that the widely differing climates of the world will require just as varied methods of providing protection against their different inclemencies.

Clothing is largely a matter of climate and varies from the heavy fur garments of the Eskimo and other Arctic inhabitants to the loin cloth of the dwellers in the tropics.

Again, the materials of the clothing vary with the animal and vegetable materials available, and these are definitely climatic responses. In the cold regions only the products of animals are at hand. In the Pacific Islands a bark cloth is used. In Peru the hair of the alpaca is the main basis of clothing. The style of wearing the clothing also varies with the climate. In the cold regions the tendency is for the clothing to fit the body tightly, but flowing loose garments are the rule in the warmer countries. The Arab wishing to protect himself from the scorching rays of the desert sun, and the stinging blasts of hot sand particles, swathes himself in yards and yards of white woolen materials.

In the case of shelter (that is, the dwelling or house), we find equally varied materials, depending upon the climatic conditions, pressed into service. The Eskimo uses blocks of snow for his building materials for his winter dwelling, and tents of skins for the summer. Bamboo is the main building material of the lands where it grows. Palm leaves, reeds, grasses, straw, tiles, slates, shingles, are used for roofing materials.

On the Asiatic steppes the skins of animals or a felt made from the hair of animals are used to make dwellings by the Nomads of those regions. The Mexican uses adobe, or sun-

dried bricks, whilst other peoples sometimes utilize caves which have been eroded out of the rocks by weather conditions of the region.

51. The Effect of Climate on Health and Energy. The relation of climate to health and energy is shown by the following examples:

The farmer or planter in equatorial regions cannot possibly work as hard as his brother in temperate regions. You have only to contrast your own reaction towards work on a hot day with one in the spring or fall, in order to realize how true this is. Again, if the climate is too cold, such as we find in the far north or far south, the cold numbs both mind and body and so prevents progress.

Equatorial climates definitely react upon health in that they have forms of diseases peculiar to them, and which take terrible toll upon human life: Malaria, sleeping sickness, hookworm disease, cholera, yellow fever, and so on are examples. The late Sir William Osler says:

"Cholera kills its thousands; plague, in its bad years, its hundreds of thousands; yellow fever, hookworm disease, and tuberculosis are all terribly destructive, but malaria is today, in the tropics, the greatest single foe of the white man."

In India alone 1,300,000 people die annually of malaria, and 100,000,000 more suffer from its attacks.

The yellow fever bacteria have for years been the scourge of central and tropical South America, and the wonderful story of the Panama Canal was a fight mainly against this disease. The hookworm scourges the human race to a terrible extent. Its range is as far north as Nashville, Tennessee, and Osaka in Japan, as far south as Valdivia, Chile, and Wellington, New Zealand; a zone which embraces more than one-half of the world's population. It is within this zone that most of the world's backward people live, and there is ground for placing the blame for much of this backwardness to the effects of the hookworm disease. The malady caused by this worm is one of the most serious afflictions to which mankind is subject. It lowers the victim's resistance to other infections, dulling the mind, sapping the strength. Its effects are stunted mental and physical growth which leads to degeneracy and decay. It is a fearful scourge in the Southern United States.

Tropical Sleeping Sickness—

This has no relation to the malady bearing the same name which appeared in Canada during the last few years. It is most virulent in Central America, where it has literally wiped out some of the most vigorous of the native races of that country.

If you will take a map of the world and carefully note where are the most highly civilized nations (that is to say, those equipped with the energy and health to give the necessary mental alertness required to lead in the march of progress), you will

find that they all attain their greatest development between latitudes 40° and 50° in the Northern Hemisphere. In the Southern Hemisphere the greatest progress has been made by those descendants of Europeans who have settled between latitudes 35° to 48° south.

These two zones are climatically similar, and are noted for the variable nature of their climate. This fact has led to considerable research on climate, and one of the most noteworthy and recent of the investigators, Dr. Huntingdon, of Yale University, gives the following characteristics as providing the "ideal climate":

(1) It must have cool, but not cold, winters as a mental stimulus, and warm, but not hot, summers as a physical stimulus.

(2) It must have a fairly high humidity except in the warm weather.

(3) It must have frequent changes of weather.

He picks out South-East England in the Northern Hemisphere, and New Zealand in the Southern Hemisphere, as the countries most nearly attaining these conditions. He also says that Japan would fall in this class if the people were not crowded in the south, where the summers are too warm and moist. The Western United States he classes as very good, but just failing in the third necessity, viz., variability. The Eastern United States and Eastern Canada fail because of the high humidity and temperature in summer and low winter temperature, but are nevertheless favorable climates, but not ideal.

CHAPTER III.

Relation of Natural Barriers to the Social Development of Races.

52. Lack of Natural Barriers Produces a Nomadic People, e.g., the Arabs.

It would be more correct to say, the lack of natural barriers facilitates the production of a nomadic race.

The real reason for nomadism is not the absence of natural barriers. It is the food and water supply. It is true that the great nomadic races of the world have all developed in regions where the topography of the land offered little resistance to man's movements. It is also equally true, that these movements were forced upon them by climatic conditions, which compelled them to wander from place to place with the seasonal variations of the food supply.

The great nomadic races of the world fall naturally into four great groups:

(1) *The Tundra or Frozen Desert Nomads,* like the Eskimo, the Samoyedes, Lapps, Tunguses.

(2) *The Steppe or Temperate Grassland Nomads,* such as the Kirghiz of Central Asia, the North American Indian, the Patagonian of South America and, in a lesser degree, the Boers of the South African High Veldt.

(3) *The Savannah or Tropical Grasslands,* for example, the Bantu races of Central and South Africa.

(4) *The Hot Desert Nomads,* viz., the Arabs, Tuaregs, etc.

The Arabs may be taken as typical of the nomadic races. They are to be found in the great hot deserts of Northern Africa, and the Arabian peninsula. The Arabs are divided into tribes, the principal ones being the Tuaregs, Senussi, and the Tibu in the Sahara and Libyan deserts. In Arabia they are principally Bedouins.

Throughout all this region the population is partly settled and partly nomadic. The settled portion of these tribes inhabit the greater oases, which, although they are in the desert, are not really a part of it, since in them the desert vegetation is replaced by one typical of a well watered region. Besides these greater oases, where crops like barley, wheat, millet and fruits may successfully be cultivated, there are numerous smaller ones, where almost the only vegetation is the date palm and the camel thorn.

These small or palm oases are found where the little springs issue from the ground, or where wells may be dug to reach the underground water.

Outside the oases, agriculture is impossible and the desert people or nomads are forced to rely for a living upon sheep, goats, donkeys, and camels, which are about the only animals capable of subsisting in such regions. These animals quickly eat all the vegetation of these small oases and must therefore be constantly on the move from one to the other. Thus it is that the peoples of these regions are forced into a nomadic or wandering type of life. Now it will be easily seen that if these oases were separated from one another by high ranges of hills, or other great natural barriers, the inhabitants would be unable to wander easily from one feeding ground to another. Thus it is clear that the absence of natural barriers greatly assists in the production of nomadic peoples. It must, however, be always kept in mind that the great urge of the nomadic races is the search for food and water for their animals.

This wandering style of life has produced a peculiar social development, the principal features of which are common to all types of nomads:

(1) They all have the "Patriarchal form of government." That is, each wandering group is usually a family group in which the "word of the father" is the only law. It sometimes happens that for greater protection against raids from other family groups, that several families band themselves together. They then elect one of the older men who is the sole law-giver, and leader of the band. Among the Arabs such a man is called a "Sheik." Often the office of "Sheik" may become hereditary, but that is very dependent upon the character of the man who is next in line, since upon the ability of the leader to command depends the safety of the tribe.

(2) Democracy. All nomadic races have strong democratic tendencies. This is a logical result from the simplicity and the dangers of their mode of life. At each migration all the moveable goods of the tribe must be transported. The limitations of transport and the danger of complete loss by raiding forces everyone to reduce his belongings to an absolute minimum. Then, again, the comparatively small size of the group throws them all into intimate contact with each other. Also the safety of the band dare not be risked by those natural jealousies, which would surely occur, if there were too great a disparity between the comfort of the individuals.

(3) Art. The wandering nature of their mode of life produces a great similarity in the principal types of art. These principally find expression in the making of clothing, rugs, and carpets, as well as ornamental leatherwork. Nothing else would stand the wear and tear of constant packing and unpacking and other exigencies of travel.

(4) Hospitality is a universal characteristic of these peoples. This is the inevitable result of the fact that the nomad has to wander, and that his life often depends upon the hospitality of other encampments.

(5) Raiding. All nomads will steal from each other. They do not look upon raiding with the same horror as do the settled peoples. Often the tribe has no other means of keeping alive than by robbing another encampment. Hence they raid one another or sometimes join together to raid settlements in order to obtain the wherewithal to feed their families and flocks. The most of the raiding is done between the nomads themselves, since it is far harder and more dangerous to raid a village than to raid a camp.

(6) Food Habits. Aridity, as we have seen, is the principal cause of nomadism. Water is, therefore, always more or less of a scarcity with them. Their principal drink is the milk of their animals. In the Sahara or Arabian deserts this scarcity of water is most extreme. At certain times of the year the milk of the camels is the only liquid available, so the Arab horse is taught to drink milk. Often food becomes so scarce and the herds are so reduced that the Arab dare not slaughter any more. He and his family then subsist entirely on milk. The Kirghiz Nomads live principally upon mares' milk, koumiss and cheese. The Arab's staple food is dates, goat mutton, camels' milk, and very strong tea made sickeningly sweet.

No better descriptions of nomadic life are to be found than those of the Old Testament. The daily life of the Arabs and the Kirghiz differ very little today from that of those Old Testament peoples.

53. Isolation by Deserts.

The ancient Egyptians and Assyrians are the typical examples of races which have been able to rise and become great nations because of their isolation by deserts. We will consider the case of the Egyptians. Look at the map of Northern Africa and it will be seen that the land of Egypt is merely the narrow strip of fertile land which forms the banks of the river Nile, together with its great delta, spreading like a fan from Cairo to the sea. It is about 600 miles long and from Cairo to its junction with the Blue Nile, it has only an average width of about seven miles. Yet since the very dawn of history this narrow strip of land has been, and still is, one of the great agricultural regions of the world. In this narrow valley there is today concentrated a population of more than 12¾ millions. Since the beginnings of historical times it has always supported a teeming population. Three different sets of conditions have been responsible for this remarkable condition of things:

(1) The river.
(2) The annual inundation.
(3) The desert.

Egypt is often called "The Gift of the River." This is literally true, for Egypt is by nature a rainless land. It is the Nile, and only the Nile, which each year converts what would otherwise be a desert, into a land of smiling fields.

In order to understand this wonderful river, we must consider two remarkable geographic facts, viz.: The sources of the Nile, and its annual inundation. More than a thousand miles south of Khartoum there lies a plateau where rain falls steadily for ten months of the year. This stupendous rainfall is drained into vast rocky depressions forming the great lakes of Equatorial Africa. These lakes filled to overflowing by the incessant rainfall feed two of the greatest rivers of the world, the Nile and the Congo.

The Nile flows northward across the great Sahara and Soudan deserts, but the gigantic reservoirs of the three Nyanza lakes pour out inexhaustible supplies of water and so the mighty river is able to cross the whole length of the desert and eventually reaches the Mediterranean Sea. The existence of the Nile is due to the Nyanza lakes alone. The inundation, however, is due to a distinct and separate cause, viz., the Indian Ocean monsoon winds together with the Abyssinian Highlands. These are situated between the Nile and the Arabian Gulf. They rise many thousand feet above the sea level, and force the moisture-laden moonsoon winds from the Indian Ocean to rise, cool, and therefore shed their vapor.

This rainy season occurs during the summer. In the winter these Abyssinian mountains are covered with snow. These melting snows added to the heavy rains of the summer cause two great rivers to come thundering down their almost dried-up beds and rush into the Nile. These are the Atbara and the Blue Nile. The main stream is now forced irresistibly along. It crosses the Nubian desert between walls of rock which save it from losing itself among the sands, or debouching into the Red Sea. As soon as it reaches the low-lying lands of Egypt it naturally overflows them, producing the annual inundation which takes the place of rain in the fields of Egypt.

But these Abyssinian tributaries do more even than this. The waters of the White Nile, since they flow out of great lakes, are pure and clear, but the Atbara and the Blue Nile bring down from Abyssinia a black silt, which the flood spreads over the whole valley as a sort of top dressing. As soon as the flood waters have receded the Egyptians cast their seed upon the rich, moist mud. This is what is meant by the Biblical allusion of "casting their bread upon the waters." Thus we see that were it not for the White Nile, the Abyssinian rivers would be swallowed up by the desert; and were it not for the Abyssinian rivers the White Nile would be a barren stream. The river is created by the rains of the equator and the land by the monsoon

rains condensed by the Abyssinian mountains. In this narrow river valley, made rich by foreign soil and watered by the rains of the equator, the ancient civilization of Egypt arose. Agriculture developed, great cities arose and the land supported a vast population. Here art, manufactures and trade flourished and were carried to Crete and Greece. From them they spread all over the world.

This development was made possible by the desert. For with the great deserts on either side, the early Egyptians were free from attack and so man had time to devote to other things than fighting. Food was plenty. People became numerous. There was abundance of stone and so architecture on the grandest scale arose. Settled government was possible. The necessity for irrigation to offset the years when there was a "bad Nile" caused the ancient Egyptians to study and master the science of hydraulics. The annual inundation naturally swept away all land marks, and so these people invented the art of surveying in order to settle the disputes which broke out every year. The cloudless skies of a rainless land enabled the stars to be closely watched, and the coincidence of the inundation with certain positions of the stars led to the study of astronomy.

Agriculture became almost a mathematical art, for it was discovered that so many feet of water would yield so many bushels of wheat, and it was possible to quite accurately forecast the harvest before the seed was sown.

This led to a separation of the people into two classes, an intellectual class and a farming class. As time went on the people of the "island of fertility" amid the deserts became rich. With improved methods of irrigation they became less liable to famines. The fierce nomads of the desert cast envious eyes on their well-stocked granaries. Raids became frequent so they were obliged to defend themselves from these desert robbers This led to the creation of a military class. The intellectual class joined with the military class and so the ancient Egyptians became divided into three groups—the intellectual class or the priests, the military class, and the workers.

54. Isolation by Seas, e.g., the British.

Perhaps a better term than "isolation" would be "insulation." Isolation always produces backwardness and extreme conservativism. These are certainly not the dominant characteristics of the British peoples.

The truth is that the separation of the British Isles from the continental mass of Europe by a comparatively narrow strait instead of a wide sea, had the special advantage of keeping the British ,or especially the English, out of the common broils of Europe, but did not prevent communication with the continental peoples. This separation, without the disadvantage of complete isolation, resulted in the peaceful development of the island and the early cultivation of a national spirit and conscience.

The insulation is, however, complete enough to make invasion by armed forces very difficult. Even in the early days Britain was seldom invaded, and since the Norman Conquest there has been no landing of foreign forces in sufficient strength to seriously trouble the land.

Germany, with all her armed might, was unable to inflict any serious damage during the late war. Some one has said that "from the standpoint of defence, Great Britain is like a home on piles with the plank drawn up."

This hits off the situation very happily. The result of this fortunate position is that for more than 850 years, the people as a whole have never been distracted from the labors of the field, mine, and factory by the necessity of expelling a foreign invader. During this period the British have been free to develop agriculture, mining, manufacturing, and commerce. They have thus become wealthy and great. Britain is again very fortunate in that her lands are islands having a "Coast of submergence." This has produced the extremely long coast line in comparison with her area. Again, the position of the great indentations into the land mass is especially favorable, particularly in the case of the largest island, containing England, Scotland, and Wales.

Study the map and observe how the great indentations of the coast are arranged in pairs along the west and east sides of the land, e.g., the Bristol Channel and the Thames Estuary, the Mersey Estuary and the Humber, the Firth of Clyde and the Firth of Forth.

This curious geographic fact results in no part of the island being more than 90 miles from the sea. Now add to this the scores of ports, great and small, from which issue hardy fisherfolk in search of the harvest of the sea. More than 40 ports in Great Britain can receive ships drawing fourteen feet of water, twice each day. No other country in the world can show such an overwhelming superiority in deep harbours.

This circumstance has always given Britain a superiority of trained seamen when she has come into conflict with other expanding nations.

But the surrounding sea is not merely a barrier of defence. It is the most important means of peaceful communication. The nearness of the sea to all parts of the land has always turned the British people's thoughts seawards, causing them to become interested in overseas commerce and ventures in a way not possible to an inland country.

In addition, the insular position produces a variable type of climate without the extremes of a continental climate, which is considered by Prof. Huntingdon, of Yale University, to be the finest in the world for the development of an energetic and civilized people.

To sum up, the encircling seas of Britain have ensured her that internal peace which has enabled her to develop her resources and build up a strong, stable government. They give

her a favourable climate for the rearing of a sturdy, energetic, and persevering people, and they have made her the greatest maritime nation of all time.

55. Isolation by Mountains—the Swiss.

Switzerland is made up of 22 cantons, or small divisions. It is a land of high mountains, so that these cantons are almost always just one river valley, and sometimes they are only a part of one. The people live on the bottom lands of these valleys because they find there the soil to cultivate, and level land on which to build their houses. Towering above them are the high, steep and barren mountains where no one lives. These mountains form an effectual barrier between them and the great nations of Germany, France, Austria, and Italy, which surround the country.

These mountain ranges also separate the people into small self-contained unit valleys. This isolation of small communities, first from the outer world and second from easy communication with each other, has given to the Swiss those characteristics which are common to all mountain peoples, viz.: They become very clannish and conservative, and do not wish to change. They take little interest in what goes on outside their own little valley. Strangers are viewed with suspicion, but at the same time they are very fond of their homes and families. Mountaineers are bold and fearless people, very independent, and find outside control very irksome.

About 700 years ago the land was subject to the Austrian Crown, and was governed from the Castle of Hapsburg, near the junction of the Aar and the Reuss rivers. The administration was corrupt, and many hardships and indignities were heaped upon the men of the cantons. The bold independence of these sturdy mountaineers could not brook such treatment. Four of the cantons, Lucerne, Schwyz, Uri, and Unterwalden, which lie in the valley of the Reuss, were especially oppressed by these Austrian overlords, because they were more easily reached from the Castle of Hapsburg than the others.

Now these four cantons, as will be seen from a map of Switzerland, all touch the Lake of Lucerne. This fact is of the greatest importance in the development of the Swiss nation. These cantons are divided from each other in the usual way by the mountains, but they all touch the lake. In this lake the men of the four cantons fished and sailed. The lake was a common meeting place where they could discuss their grievances against the Hapsburgs and so learned of each other's affairs. The lake united them and modified the effect of the mountains, which was to keep them separate. It is in these four cantons, and with this lake, that the history of Switzerland as a country begins. Everyone knows the story of their legendary hero, William Tell. This may be a fable, but the fact that 1,500 men of these cantons actually defeated an army of 20,000 Austrians is one of the sober facts of history.

The people of these *four cantons* then formed a league of their own, which they named after the Canton of Schwyz, because the men of that canton had taken the lead in the movement.

As time went on other cantons and cities joined the league and the movement spread amongst all those cantons which wished to be free. So arose Switzerland, perhaps the most unnatural country in the world. It has no language of its own. German is the most common language spoken, but many cantons speak French, and in two they speak Italian. In religion they are divided about equally between Roman Catholicism and Protestantism. They have no unity of either religion or language.

Then, again, the people of the different cantons want to be free from the rest. They are divided by the mountains and they are divided by their own wishes. Their first idea was a league of cantons each equal to one another and each managing its own affairs. They had no liking for a central governing body interfering in their local concerns. This would have been disastrous, but men who have fought so hard as they for their freedom do not lightly throw it away. So the unity of idea added to the common danger from their powerful neighbors brought them together and behind the barriers of their mountains and lakes they made a nation out of so many diverse peoples and languages. So there has been fostered in the people an intense spirit of independence and devotion to democracy. Its laws are the most liberal in the world, and it is the asylum of exiles from most of the countries of Europe.

The heavy rainfall, the cool climate, and ruggedness of the land make Switzerland largely a grazing country. In the summer time there are splendid meadows of summer grass high up the mountain sides. These mountain meadows are called "Alps" by the Swiss. In the summer the man of the family and perhaps an elder son take the cattle far up in the mountains to these meadows. They live in a temporary hut, care for the cattle, and make cheese, as it is impossible to bring the milk down every day. At the little farm in the valley, the other members of the family are growing oats, barley, and rye, and making hay for winter fodder for the cattle. The winter milk is turned into condensed milk and milk chocolate, which are distinct national products of the Swiss, forced upon them by their isolation by their mountains.

56. Isolation by Mountains and Seas, e.g., the Ancient Greeks.

If a map of South-Eastern Europe be carefully examined with regard to the physical features of the region, the following facts become apparent

(1) The Eastern coast of Greece and the Western coast of Asia lie side by side.

(2) They are separated by a narrow sea dotted with islands which lie like stepping stones across a stream.

(3) A great mountain mass curving across from the Adriatic to the Black Sea shuts off Greece from the rest of Europe.

(4) The coasts, especially the Grecian, are very deeply indented by the sea. These greater indentations abound in deep and sheltered bays, affording many safe harbours.

(5) Spurs of the great mountain range inclose extensive tracts of land which have the appearance of large basins. These basins are level and have a rich alluvial soil. They are in fact plains ringed round by mountains but open on one side to the sea.

The climate of the region is mild. The atmosphere is clear and rarely cloudy. The sea is remarkably free from great storms. Altogether the region is very favorable for that type of navigation which does not depend upon the compass, but rather upon the eye, in sailing from point to point, and island to island. Such is the region in which the Ancient Greeks found themselves at the dawn of civilization.

Now, as we have seen before, the general effect of mountains on a race is to produce backwardness, conservatism and extreme individualism, but the Greeks were saved from this fate by the broadening influences of the sea.

In each inclosed basin and on the islands of the Aegean Sea arose a series of independent city states. Each possessed its own home-made constitution, and each differed somewhat from the others. Some states were monarchies, some oligarchies, and still others were democracies. In some agriculture was the chief industry, whilst others were trading communities. In fact they were as diversified as is the geography of the whole region.

The nature of the region is very favorable to defence and also to the launching of an attack. The mountains around their little plains were natural ramparts, which protected them from sudden raids on the landward side. They early learned to defend the river ford and the mountain pass. If these were forced they retired to those citadels with which they crowned the rocky crags dotted like islands over the plain. If these fell they still, as a last resort, had the almost inaccessible mountain caves in which to hide, and from which they could sally forth and start again after the danger had passed.

To those Greeks who chose to dwell on the islands, the sea gave sufficient isolation to allow them to develop in their own individual manner. But it also allowed them to pass freely from place to place and prevented that extreme form of sectionalism seen in those mountain regions which are far from the uniting influence of the sea.

The location of the region was also favorable to the early Greeks. It is almost midway between those two great centres, Egypt and Babylon, from which we believe the western civilization sprang. This middle position enabled them to receive

ideas from both: The Asiatic side gave them arithmetic, letters, and astronomy, and a grounding in trade methods. From Egypt they received ideas of architecture, sculpture, and surveying.

The independent and inquiring spirit of the Greeks improved upon these ideas and their innate love of freedom released the bonds of convention with which the Asiatic and Egyptian civilizations had shackled them, so that they burst forth in the mighty stream of Grecian Art and Science. So it will be seen that the Ancient Greeks owed their early development to their isolation from the fierce nomads of the north by the great mountain mass of Europe. They were protected from the great civilizations of Egypt and Assyria by the isolation of the sea, for neither of these nations ever became a seafaring people.

They owed their great diversity and disunion to the internal isolation caused by mountains and seas.

To the unifying influence of the sea and the sight of still another island or point to reach they owed their unity of religious ideas and their inquisitive minds.

Both mountain and sea contributed to their boldness and capacity to do the right thing in an emergency.

But the isolating tendencies of the distribution of the mountains of their land prevented them from maintaining themselves as a world power for very long periods.

57. Isolation by Mountains and Deserts, e.g., the Chinese.

In this instance we have an example of a very complete form of isolation. Deserts are perhaps the completest of all the great geographic barriers. Mountains are also very effective barriers. In earlier times, that is, before the invention of the steamship, the ocean was perhaps almost as complete a barrier as a desert.

But imagine how complete must be the isolation of a people surrounded by all of these three great natural barriers. This is the position of the Chinese. Study it out on the map of Asia. Ringed round on the North and West by a double barrier of stupendous mountains and hot deserts as well as high, cold plateaus, China was inevitably shut off from contact with the civilizations of the Mediterranean lands.

On the east the broad expanse and stormy seas of the Pacific Ocean were effective barriers to the efforts of early navigators. Even had some bold Chinese explorer succeeded in crossing the Pacific Ocean, he would have been completely halted by the great mountain mass of the Western Cordillera of the two Americas, which literally have their feet in the sea. China, therefore, especially in days when transportation lacked the powerful aid of steam, occupied a position of profound isolation. Only two other regions of human habitation vie with China in this regard. These are Japan and Australia. The isolation of China has been

all the more complete because its landward boundaries are not artificial frontier lines, such as a line of latitude or longitude, but great expanses of land of a peculiarly suitable nature to produce isolation.

Then, as if these were not sufficient, the Chinese added to their isolation by the construction of the Great Wall, 1,500 miles long. Inside these mighty barriers the Chinese were so isolated that they came to look upon themselves as the centre of the world. Their own name for themselves, "Chins," means "The Men."

The region in which they live is characterized by three main features: isolation, fertility, and extremes of dry cold and damp heat. Their isolation has prevented them from adopting new ideas. For thousands of years there were few visitors to bring new words and ideas. They lacked the means of comparing the way they had learned to do things with the manner in which other nations accomplished the same results. This lack of exchange of ideas has had very curious results. Their language is still a very primitive one, consisting of words which are nearly all of one syllable. The writing is one of the most primitive types known, and is extremely cumbersome. Its alphabet contains over 400 different characters, each one of which has several meanings. This means that a large portion of the time of a Chinese student is occupied in mere memory work. He has to learn his great classics off by heart. Chinese examinations are really tests in the memorizing of the poems and sayings of their great literary men of a past age.

This has the effect of retarding progress in the liberal arts. Another curious result of this isolation is seen in the way in which the Chinese does things in the opposite way from which we usually do them, e.g.: He commences his writings at the bottom right hand corner of a page. He saws wood with a saw which cuts wood on the up stroke instead of the down stroke as ours does. The native Chinese plane is operated by drawing it toward himself instead of pushing it away from the body. If a Chinaman is perplexed, he scratches his heel and not his head.

The Chinese are a curiously homogeneous people. This is partly because of the character of their frontiers, and party the result of the similarity of the occupations of the people. The land is densely populated, supporting the largest population in the world (over 440 millions according to an estimate of the Chinese Maritime Customs in 1923). Only the fine fertility of the land and the patient, unremitting toil of the people enable so many people to be a self-supporting nation. Their isolation has forced this character of frugality and industriousness upon them, since they were practically unable to receive material from outside countries. Agriculture is the basic industry. Since so many mouths must be fed, by far the greater number of the people must perforce become farmers, for their isolation, until recent times, prevented them from supplementing their own crops by the aid of foreign trade.

58. Relation of Environment to Development of Racial Characteristics.

Geographic conditions, although not the only contributing factor, are a basic influence in determining the race habits, occupations, mental characteristics, moral standards and religious beliefs and practices of the races of man. Scarcity or abundance of food has always been instrumental in creating habits of thrift or carelessness. The thriftiness of the European peasant, who is always haunted by the spectre of starvation and the extravagance of the American working classes are in direct ratio to the available food supply of the two continents.

The meagre crops and fear of hunger have developed among the nomads of the arid regions a standard of ethics which is almost incomprehensible to the peoples of more favored lands. Mountainous regions can only support a sparse population because of their limited food supplies. People who live in these regions become isolated from the rest of the world and so achieve slowly political, social and religious solidarity. Mountain dwellers possess to a high degree a love of personal freedom, and are inclined to resort to violent methods in defence of their traditional rights and liberties. In such regions education is slow, specialization rare and illiteracy very common. Climate is the most far reaching factor of all the geographical influences in its effect upon man. It fixes the three main methods by which he shall obtain his materials for food, clothing and shelter, viz.:

(1) Direct appropriation from nature, as in tropical countries.

(2) The application of careful forethought, ingenuity and vigorous expenditure of energy, as in the temperate zones.

(3) The intense utilization and careful conservation of the scanty resources of those parts of the earth which have severe and extended cold seasons, or an insufficient rainfall, as, for example, the polar regions and the hot deserts.

The lazy habits and carelessness of the African negro are a result of the first condition. His food is ready for him in the form of bananas, yams, nuts, wild fruits and game, while the rivers teem with fish. He has only to reach out and take what he wants. He has no incentive to work. The warmth makes him indifferent to the use of clothing. The simplest form of shelter is all he requires to protect himself from the rain. He lives the life of a day and takes no thought of the morrow. Hence foresight is only rudimentary among these races. The second method by which man must supply his needs is that which is required in the temperate zones. In these regions, life is hardly possible without sustained effort. The succession of the four seasons is nowhere so clearly marked as in the North Temperate Zone. Here it is necessary for man to carefully plan

his labour, his time of planting and harvest, and he must in a relatively short time obtain a sufficient surplus of food to carry him over to the next harvest.

All this calls for forethought, ingenuity and energy. In consequence the North Temperate Zone is the home of civilization. In this zone, the rewards of labour are generous. Effort is not harmful to health. The temperature and light conditions are favorable to industry. The changefulness of the seasons demands flexibility of physical adaptation and a development of economy and foresight.

The third mode of obtaining the necessities of life is by far the most strenuous. In the regions where this method must be pursued we find the most backward races of the world. The Eskimo is a typical example of a race living in an environment made unfavorable by extreme cold. His environment has indelibly stamped upon him his racial characteristics.

In the bleak, windy, treeless and bitterly cold region which forms the shore of the Arctic Ocean he has an environment which forces him into constant conflict with nature. The available food supply is scanty and much of it migratory. He requires heavy protection against the cold, but fuel is scarce, and building material, as we understand it, is almost non-existent. The climatic conditions preclude the production of vegetable fibres for clothing. He is, therefore, totally dependent in this respect upon the animal life of the region. This is mainly aquatic, although in summer the migrations of the caribou bring him some relief.

His principal resource is the seal, which gives him food, fuel and clothing. Fish also is a staple food supply. These are eked out in the summer by caribou and musk ox meat, water fowl and berries from the tundras. His houses are caribou skin tents in the summer and snow huts in the winter. His tools and weapons are masterpieces of ingenuity when we consider the type of materials used in their construction. His fearful struggle against his environment, however, leaves him little time for the development of the higher things like art, and literature. The Eskimo is, however, not entirely deficient in these respects as his ivory carvings, clothing ornamentation and pictures made with the soot from his seal blubber lamps plainly show. The occasional construction of his kayak from bones and skin argues an inventiveness only repressed by the type of material which his environment furnishes him.

Some races are dependent upon a single resource. The South Sea Islander is an example. Living on coral islands, often only a few feet above sea level, he has only the cocoanut palm and fish from the sea. These provide him with food, shelter and clothing. The climate, however, is the Oceanic type, that is, free from extremes of heat and cold, and very uniform not only from day to day, but from year to year. This produces a rather

monotonous type of existence. The smallness of the islands and their isolation from the rest of the world has combined with the monotony of the life to produce a backward type of race of a rather lazy and improvident type.

Closely connected with climate is the presence of many parasitical diseases, such as malaria, yellow fever, hookworm, dysentery, cholera, etc. The effects of these on the health and energy of man have already been noticed.

Many other instances of the result of environment on the races of man might be cited, but space will not allow separate treatment of all.

One other type will be considered, viz.: the influence of the distribution of inorganic materials.

Distribution of Inorganic Materials.

The distribution of water and salt is of very great importance to man. We are not so apt to realize the value of salt and water in human life as are the races whose environment is deficient in this respect. Salt is one of the necessities of life, although only small quantities of it are required. The Arab finds salt so precious that it is one of his prized possessions, so valuable is it to him, and so deficient is his environment in this particular that it has become almost a holy thing to him, and a symbol of good faith.

The desire of European nations to possess precious metals and stones not readily found in their region was one of the dominating influences causing the great era of discovery during the fifteenth century. The changing of England from an agricultural nation to a manufacturing nation in the eighteenth century was due to the very fortunate juxtaposition of its coal and iron deposits. The industrial nature of the region around Pittsburgh is due to the simultaneous presence of coal, iron, petroleum and facility for land and water transportation.

PART II

INDUSTRIAL GEOGRAPHY.

CHAPTER IV.

Conditions Affecting Production, Distribution, and Exchange of Commodities.

59. Climate.—The effect of climate in this regard should have become apparent during the treatment of climate in the preceding chapter.

60. Soils.—Soil and climate are the two great factors which determine the variety and abundance of plant life. Since all animal life depends, either directly or indirectly, upon the food produced by plants, it must be evident that these two factors are of extreme importance to man. The control or modification of climate is beyond the powers of man, but he is able to strongly modify and control the condition of the soil.

Soil, then, should be the object of very careful study, since it is a fundamental geographic control in fixing the amount and kind of food supply available for man.

From the soil come the principal articles of commerce, and its cultivation is the basis of civilization. It has been estimated that in France 50% of the population are agriculturists, whilst in Russia 90%, in India 95%, and in the United States 35% of the population are engaged in agriculture.

61. Formation of Soil. Ample information respecting soil formation may be obtained by consulting the agricultural text-books authorized for use in Grades X and XI for Alberta schools.

62. Types of Soils. Soils are of two main types:

(*a*) Residual.

(*b*) Transported.

The transported soils may be conveniently further subdivided into:

(1) Alluvial soils.

(2) Glacial soils.

(3) Aeolian soils.

(4) Talus soils.

Full information as to the character of these various classes of soil may be obtained from the reference just quoted. Here it is only necessary to point out the principal geographical locations of these different soils.

63. Residual Soils have examples in the irrigated lava plains of Idaho and Washington, the laterite of India, and the well known "Black Earth" of Russia.

64. Alluvial Soils constitute the soil of the flood plains, deltas, alluvial plains and valleys of the world. Examples: The valleys of the Po, the Ganges, the Nile, the Volga, the Guadalquiver, the Parana, the Theiss, and the Mississippi are the most important river flood plains from the food supply point of view. The flood plains of the Mackenzie, Ob, Lena and other North American and Siberian rivers are examples of flood plains rendered of small value to man by their severe Arctic climate. The Euphrates, Tigris, Oxus, and Lower Colorado flood plains are examples where aridity destroys their value as food producers. The most important river deltas are those of the Nile, 90 miles wide by 180 miles long; the combined delta of the Ganges and Brahmaputra rivers having 220 miles of sea frontage and extending 200 miles inland; the Orinoco delta (7,000 square miles); the Rhine, Meuse, Sambre and Scheldt deltas whose plain forms the Netherlands; the Mississippi delta having an area of 12,500 square miles above water of average level. The Hwang Ho delta extends 400 miles along the Chinese coast and 300 miles inland. This delta is extremely fertile and has the remarkable population of more than 800 people per square mile.

65. Glacial Soils show many aspects and are of all degrees of fertility. All classes of glacial soil show great variation in character within short spaces. Scandinavia, Britain, the Baltic plain of Germany, New England, New York, Ohio, Michigan, Indiana, Iowa, Minnesota and Canada are covered with glacial soil. In addition many mountain valleys all over the world owe their fertility to the action of glaciers, some of which are not now existing.

66. Aeolian Soils. These are soils produced by the action of wind. They are always fine textured, since the wind cannot transport coarse materials to any great distance. The term "loess" is usually applied to this type of soil. "Loess deposits" are always of great agricultural value since they make plains which are very easily tilled.

The rich lands of the Upper Hwang Ho, much of the corn belt of Nebraska, Iowa and Missouri, as well as some of the choicest farming lands of the Danube and the Rhine, are examples of Aeolian soil whose climate and position make them useful to man.

67. Talus Soils. These are the soils which form a slope of loose fragments which have been broken from the rock ledges

or cliffs above them. In the temperate regions of the world these fragments are weathered into a soil which forms a slope. This slope is almost always that which has the most favorable sun exposure. When the climate is suitable they are particularly suited to fruit-raising and grape culture. Many of the finest vineyards of France are found on these talus slopes at the foot of the central plateau of that country. In South Africa the great vineyards of Wynberg, Constantia, etc., are located on the talus slopes of Table Mountain.

68. Fertilizers. It was stated in paragraph 60 that man is able to modify and control the condition of the soil. This he does by tillage and by the addition of fertilizers. Some soils are short in lime, others in nitrogen, and some lack potash. These must be supplied if the fertility of the soil is to be maintained. Gypsum, lime, marl, phosphate rocks and caliche or Chile saltpetre are all soil products used as fertilizers, and which must be transported from their source to the fields where they are to be used. In addition, bones and ash from the great stock yards of South America, cotton-seed waste, refuse from slaughter-houses, seaweed, fish, slag from blast furnaces, farm manure and street sweepings are all important sources for fertilizing agents.

The trade in these commodities is far greater than is usually supposed, and is gaining volume each year.

69. Human Elements. The most important human elements which affect commerce may be stated to be:

(1) The degree of civilization.
(2) Racial characteristics.
(3) Density of population.
(4) Government.
(5) Health and energy.
(6) Language and customs.

70. Degree of Civilization. We may broadly distinguish three great conditions of mankind, in respect to civilization:

(*a*) Savage;
(*b*) Barbarous;
(*c*) Civilized.

Savage Peoples are those who are the least advanced. They are wild and untaught. Their clothing and weapons are rude. Their food consists of wild fruits, nuts and roots, together with such animals as they can kill with their simple and primitive weapons. They often display remarkable ingenuity in the methods they employ in the chase, and are quite capable of killing animals of great size and strength.

They have few wants outside the satisfying of the immediate pangs of hunger, and the search for shelter from the elements. They are very self-contained and have little realiza-

tion of value, therefore their commerce is practically nil. Examples of peoples in the savage condition are the Aboriginals of Australia, many of the tribes of Central Africa and some of the Indians of North and South America.

Barbarous Peoples are those who have attained some progress in the arts. They can shape rough pottery, have learned the art of weaving and dyeing. They have tamed some kinds of wild cattle, goats, etc. Some have given a little attention to agriculture, but do not depend upon it. They have improved the crude weapons of the savage. They have not yet learned to write and consequently do not possess a literature. Typical examples are the Mongolian tribes of Central and Northern Asia, and some parts of India. They carry on a fairly considerable commerce, mostly by barter.

Civilized Peoples include those peoples who have learned to write and are therefore able to leave records. There are great differences between the upper and lower ends of the scale of civilization and it is customary to speak of those most highly civilized as the "enlightened races."

These three conditions of mankind affect commerce as under:

In the savage state we find peoples who have no commerce, or only the faintest beginnings of it.

Barbarous nations carry on a considerable degree of trade with the more civilized nations surrounding them, largely carried on by barter.

With the peoples possessing a low degree of civilization the commercial activities become more extensive. They are able by virtue of the accomplishment of writing to keep systematic accounts and they add a rude system of credit, and payment by orders, to the system of barter employed by the barbarous peoples.

The enlightened races show us commerce at its greatest extent. All the resources of the nation, natural, social and scientific, are called upon to play their part in the search for and production of the materials of commerce. Amongst these nations commerce is king, and almost the whole energy of their peoples is bent, either directly or indirectly, towards furthering its object.

71. Racial Character. The races of the world differ from each other in many ways, among which may be mentioned—

(1) General appearance.
(2) Colour.
(3) Capacity for work.
(4) Intelligence.

It is usual, however, to classify the races of mankind according to their skin colour. Even this form of classification pre-

sents difficulties, some recognize five major divisions and others only four, and yet another school considers that the Red and Brown Races are only off-shoots of the Yellow Race and that the classification could be reduced to three types, viz.: White, Yellow, and Black Races. The usual classification adopted is given below:

(1) The White or Caucasian Race.
(2) The Yellow or Mongolian Race.
(3) The Red or American Race.
(4) The Black or African Race.
(5) The Brown or Malay Race.

In considering the races of mankind the following facts appear to be the most important from the commercial geography point of view.

The White or Caucasian Race comprises the greatest number of peoples, including almost half the present population of the world. They are the most energetic and intelligent of the races of mankind and display great aptitude for trade, the greater part of the earth and its trade being controlled by them. Their great characteristics appear to be high mental development, activity, progressiveness, and a great capacity for trade.

The Mongolian or Yellow Race includes some of the most backward peoples of the earth. It is as a rule not a progressive race although industrious. The most civilized nation belonging to this race is the Japanese, who are a striking exception to the general non-progressiveness of this race. This race forms the second largest division of mankind.

The Red Race has little initiative, is low in energy, and generally speaking is a decadent race. It plays little part in the commercial activity of the world.

The Black Race is, generally speaking, rather indolent, and its members are apt to be very impulsive and childlike in their ways. It is the third largest division of the races of man, and very virile. In recent times black peoples have migrated from tropical parts of Africa and are now increasing at a great rate on the healthy plateaus of South and Eastern Central Africa.

Under the firm governments of the more enlightened white nations they are showing great aptitude and their progress during the last 25 years has been very remarkable. The greater part of the race, however, is very backward, steeped in superstition, e.g., belief in witchcraft. The Aborigines of Australia, who are generally considered to be the very lowest type of man inhabiting the earth today, belong to this race.

The Brown Race inhabits the Malay Peninsula, the East Indies and the Philippines and the islands of the Pacific. They are as a rule unprogressive, low in energy and include some of the most backward peoples.

72. The Density of Population.... This is a very potent factor in the commercial activity of a region. One of the fundamental requirements of a great commercial trade route is that it shall connect centres of population.

The population of the world is steadily increasing. This must inevitably result in an intensification of the struggle for existence.

When the population of a region is great or is on the increase, specialization in industry always follows, and the inhabitants are forced to a steadily increasing effort to more completely use all the resources of the region. This, of course, results in a larger number of people being supported on the resources of the country.

The nature of the industry carried on in a given region also influences the density of its population, e.g., a pastoral region (ranchers, etc.), is always sparsely populated, whilst a manufacturing region or a coastal region near a great trade route results in the crowding of the population in small areas and the consequent growth of cities.

The physical conditions of a region often exert a marked effect on the density of the population of that region.

Unusual weather conditions, catastrophic convulsions of nature, and the existence of animal or vegetable pests, the prevalence of droughts or the liability to flooding, all influence the density of population in regions affected by them.

The discovery of or the development of new resources leads to the establishment of industries and so increases population density. On the other hand, especially in mining and lumbering regions, the depletion of a resource causes an evacuation of the population.

In Canada, the Yukon district may be cited as a classic example. Emigration and immigration have an effect on density of population which should be too obvious to need any elaboration.

73. The Government of a Region plays an extremely important part in the settling up of that territory. No matter what the natural advantages of a region may be, it cannot attain its fullest development without the aid of a government strong enough to protect both life and property. Mexico is an example of a country having almost unrivalled natural resources, but is not supporting its rightful quota of the world's population, because of the impotence of its government.

The functions of a government, whatever form it may take, are fundamentally—

(1) To guard the rights of property on land and sea.
(2) To safeguard the lives of its people in every way.
(3) To make laws and administer them without fear or favor to all classes of its subjects.

(4) To maintain and guarantee lawful standards of weights, measure, and value.

(5) To afford protection to commerce from the hazards of nature.

(6) To promote transportation.

(7) To investigate and protect natural resources such as mines, soils, and climate.

(8) To prevent unlawful and unjust restraints of trade by monopoly or political jobbery.

(9) To obtain and distribute information regarding markets and crops, new products, and commercial conditions obtaining in other countries.

(10) To foster education.

74. Health and Energy. These are two conditions very closely dependent upon each other, and they in their turn are very dependent upon *climate.*

There can be no doubt that a healthy, vigorous person will accomplish more work than one who is weak and ailing. He will also be a greater factor in the business world, because his judgment is not so likely to be warped by his bodily condition.

Modern study has shown that there are certain regions of the earth which are more favorable than others for the production of healthy, vigorous races of mankind, and that climate, energy, health and civilization work together and that with them go the prizes of commerce.

75. Language and Customs. These exert an influence on commercial relations which is far greater than is usually supposed. Custom or habit is very deeply ingrained and it is really astonishing how small a matter will prevent the fullest expansion of trade between even civilized nations.

In the case of language, people naturally prefer to do their business with someone they understand. Hence this merely personal action must in the aggregate affect the trade between nations.

Besides this personal reaction, some languages are so clumsy in their structure that they are not at all suited for commercial use. The Chinese and Japanese languages are instances. The old-fashioned German script soon disappeared before the exigencies of the struggle for a world supremacy in trade.

Many very amusing incidents regarding the effect of custom on the trade between nations might be cited, but we will content ourselves with one or two culled from the reports of the Canadian Trade Commissioners reporting to the Dominion Department of Commerce—

"Ordinary French carpenter hammers have been able to get the bulk of the trade. The square head and face instead of the round type of hammer, common in Canada, commands the

sale in this market, and to endeavor to foist our taste in preference to the other is to court disaster all round.''—From report of the Canadian Trade Commissioner for Northern Africa.

Writing from Java, Mr. A. B. Muddiman, the Canadian Trade Commissioner resident there, says: ''The geographical factor that plays such an important part in the hardware trade must not be neglected in any real study of this market. For example, take handles for chisels. Handles for Batavia must be black, for Cheribon they should be half black, half yellow, while Sourabaya seems to be indifferent to color. Generally speaking, the poorer class tools have always red handles. As a rule, when ordering tools the color of the handle required is stated, and it is all important that this is not neglected.

''In selling hardware, as in other lines in Java, the real market lies in the purchases of 40,000,000 natives rather than in the personal needs of 150,000 Europeans.''

These examples could be multiplied indefinitely, but the above are sufficient to indicate that one of the greatest wants of modern commerce is a more sympathetic understanding of the deeply ingrained prejudices and preferences of the various races of mankind.

It is little use trying to force our ideas upon a people we wish to deal with. There are plenty of other competitors who will cater to these habits or customs and we must learn why and how they prefer their way to ours. There is often a far more valid reason than might appear at first sight.

76. Physical Features. The coast line and the relief of the land are the physical features which most strongly influence the production, distribution and exchange of commodities.

From the point of view of commerce, the nature of the sea coast is of the greatest importance. The great ocean carriers must come to the sea shore to receive and discharge their cargoes and passengers. In order to do this safely, they must find sheltered places where they may safely ride at anchor. Now a study of a map of the world will show that coasts are mainly of two distinct kinds: irregular or indented coasts and regular or smooth ones. As a rule we may say that an irregular coast offers greater advantages for the establishment of seaports than does a regular one. Regular coasts are usually deficient in good harbours, and therefore require the expenditure of immense sums in improving whatever harbour conditions may be found in them. Good harbours are the gift of nature, and their location is beyond the power of man to change. Then, again, a deeply indented coastline makes it possible for ships to gain access to points which would otherwise be far inland. In these respects contrast the coastline of Europe, with its great breaks of the Baltic and the Mediterranean seas and their numerous subsidiary breaks, with, say, the coastline of South America.

The Relief of the Land. By the relief of the land is understood the nature of its surface forms. The principal surface forms are—

Plains or regions of low relief.

Plateaus or regions of mid-relief.

Mountains or regions of high or rugged relief.

Plains are the great cereal-growing regions of the world. They are also the regions having the densest and most evenly distributed populations. They favor extensive production of commodities, and because of their easy grades are especially favorable to road-making. Inter-communication is, therefore, easy, and exchange of commodities is facilitated.

The Plateaus or Regions of Mid-Relief are, because of their altitude, usually colder than the plains. They are often subject to early and late frosts. A tendency to aridity is often a feature of plateaus. The growing of field crops is, therefore, not usually practised on them. The grazing of animals is the principal occupation in these regions. Wool, mutton, horses, cattle, etc., are the chief products. The increasing ruggedness of plateaus is distinctly unfavorable to easy communication.

The Mountains or Regions of High Relief. The ruggedness of the relief of these regions diminishes the production of most of the products which depend on plants and animals. This is due in large part to the thinness of the soil and the decrease of temperature owing to altitude. Early and late frosts are common in such regions. This results in greater attention being paid to such tree crops as olives, nuts, tea, coffee, etc. Forests are the common features of a rugged region, having a plentiful rainfall. Lumbering is therefore largely a mountain industry. Field crops are not possible to any great extent in rugged lands, hence the cereals are not a product of these lands. The principal animal products are sheep, goats, fur, etc. Cattle are not often a dominant product in mountain lands since the small size of the pastures limits the number which can be fed.

Minerals, especially metallic minerals, are most abundantly found in mountainous regions. This is so because the folding and crumpling of the rocks, and the deeply gashed sides of the mountains expose the deep seated rock formations. The erosion processes, which are very vigorous in these rugged lands, expose the metallic ore veins to the search of the prospector. Then again, metallic mineral veins are pre-eminently the product of mountain-building. (This is well shown in the *Ontario High School Physical Geography,* page 127). Mining, therefore, is often a dominant industry in rugged lands.

The exchange of commodities is very difficult in high relief regions. Mountains are the great barriers of the world and notwithstanding the skill of the engineer they offer great resistance to the location of transportation routes.

Summing up, we find that—

Broken indented coastlines favor commerce.

Low relief features favor commerce.

Mid-relief features are fairly favorable.

High relief features are unfavorable because of the great difficulties in the construction, maintenance and operation of transportation routes. They are, however, favorable to lumbering and mining industries and to certain types of agricultural endeavor such as sheep-raising and goat-raising, tea-planting and coffee-planting. Fur-trapping is also important.

77. TRANSPORT. The fundamental fact underlying all commerce is that "materials must be moved." The carrying of materials from one part of the world to another is called "transportation," and transportation facilities are absolutely essential to the development of any extended commerce. The function of transportation is to carry the raw materials of industry to the manufacturer and to distribute the manufactured products to their various markets. In addition, it must provide for the rapid intercommunication between peoples. Transportation, then, may be considered as having the following objects:

(1) The bringing together of raw materials.
(2) The distribution of manufactured products.
(3) The carrying of passengers.
(4) The carrying of information.

In order to promote commercial development to its fullest extent these four objects must be attained in a manner that is at once cheap, reliable and rapid.

Transportation must be cheap, because if the cost of transport is excessive, the goods carried will not be able to meet competition in the markets to which they are sent.

We in Alberta are confronted with this problem of securing cheap transportation for our great coal resources, which are at present shut out from the markets of Eastern Canada by the high cost of transportation.

Transportation must be reliable. That is, a shipper must be sure of his produce being delivered in good condition and within the specified time, or he will be compelled to ask an increased price in order to protect himself against this risk. Rapidity in transportation is essential to many of our modern commercial enterprises, because they deal with the collection and distribution of perishable articles.

The modern trade in fresh fruit, fish, meat, milk, etc., would be impossible under a less speedy system of transportation than we now possess.

For any large commercial activity to develop we must then have, from the transportation point of view:

Good roads.

Efficient, well managed railroads.

Commodious and well equipped ships.

Good and safe harbour facilities.

Because of these reasons, both governments and private corporations are constantly improving the means of transportation. Governments endeavor to do this by building good trunk roads through their countries, by constructing canals, and improving the channels of their navigable rivers. They also make the navigation of their coasts safer by the erection of light-houses and signal stations. They operate light-ships and mechanical devices for directing shipping past danger points during fogs and stormy weather.

Astronomical and meteorological staffs are employed, whose duties are the compiling of the necessary data regarding star positions, the keeping of exact time and the checking of ships' chronometers, etc., etc.

Private corporations, such as railroad companies, ship-owners, harbour boards and the like, are always increasing the efficiency of their services by the use of new and up-to-date machinery, and by regrading their roads to secure more favorable gradients and curves. Larger and more powerful ships are constantly being built. Dockage and harbour facilities are increased and perfected. They construct drydocks and other means of giving quick repair facilities to storm-damaged vessels seeking shelter in their harbours.

It may be considered axiomatic that—

Commerce is limited where transportation is primitive, e.g., carried on the backs of men or of beasts of burden.

Commerce is extensive where good roads and railroads or inland waterways are readily available.

78. Influences Determining Position of Commercial and Industrial Centres.

Cities exist because they are either centres for the exchange of commodities or centres of industry. In every case a city is necessarily both, since manufactures must be sold, or, what is the same thing, exchanged for the raw materials of industry. It is, however, customary to classify business centres as either—

Commercial centres, where the main activity of the people is "exchange." For example, Liverpool, Hong Kong, Vancouver, or Montreal, are primarily "commercial" in their activities.

Industrial centres, where the people are primarily engaged in manufacturing; for example, Toronto, Hamilton, Guelph, Birmingham, Pittsburgh, Lyons, Frankfort, etc.

When a purely commercial centre increases in size and importance manufacturing industries spring up. But the case may be reversed, and the originally pure manufacturing centre may also become largely commercial.

The city, then, may be regarded as the great centre of exchange, as also in a lesser degree, all towns.

Take for instance the towns scattered through the prairie provinces of Canada. What are they if they are not places where stocks of goods in common request are stored, so that they may be convenient to the inhabitants of the surrounding district? The most overwhelming advantage is some "advantage of transportation," since all manufacturing involves the moving of materials.

Sometimes, however, especially in opening up trade with new districts, defence is a very important factor, and so many commercial centres have arisen around points which lend themselves to easy defence. Hong Kong and New York are examples. The following types of sites are very favorable to the location of large cities:

(1) On the banks of navigable rivers.
(2) At the confluence of a navigable river and a tributary (even when the tributary itself is not navigable).
(3) Points where merchandise must be re-shipped, as, for example—
    (*a*) At or near the heads of navigable rivers.
    (*b*) At or near the extremities of lakes.
    (*c*) At or near the extremities of arms of the sea.
    (*d*) At great bends of navigable rivers.
(4) Where two or more important trade routes cross.
(5) At or near the mouths of navigable rivers or other deep inlets of the coastline.
(6) At falls or rapids of a river.
(7) At a central position in a fertile region.
(8) At a central position in a mining district.
(9) At large and deep harbours.

The banks of navigable rivers are suitable because rivers usually form the natural trade routes of a country. The confluence of a navigable river and its tributary is especially favorable, for even if the tributary is not navigable it will often provide the easiest route for a road, either rail or highway or canal to the interior. A splendid example of this is Albany, New York, near the confluence of the Hudson and the Mohawk rivers.

The most commanding position for a commercial city is a safe harbour which is the natural outlet for a rich and populous "hinterland." The farther inland it penetrates, all other things being equal, the greater will be its advantage, because it will enable both the importer and exporter to take advantage of the

cheaper freight offered by large ships. Montreal and New York are both advantageously situated in this respect, and hence have become the two most important international ports in North America, notwithstanding Montreal's climatic disadvantage of being frozen in for several months each year.

As examples of commercial centres near extremities of great lakes or arms of the sea, consider Port Arthur, Fort William, Chicago, Duluth, Toledo, Buffalo, on lakes; Philadelphia, Baltimore, Seattle, Vancouver, Basra, Port Arthur and Tientsin on arms of the sea.

As examples of centres on the banks of navigable rivers, consider Kazan on the Volga, Timbuktu on the Niger, Cincinnati on the Ohio. The special advantage of a location on the great bend of a navigable river is that much of the freight borne on the river is not destined for points in the new direction of the stream, and so must be reshipped.

The crossing of trade routes is a very favorable place, because here goods are reshipped and exchanged between the traders along the routes. This position also results in a gain in political importance, since such a position is a convenient one for the establishment of administrative offices. Berlin, Moscow, Paris, and Vienna are examples. Winnipeg in Canada is a splendid example. Notice how all routes from the prairies, east, converge on to Winnipeg.

As examples of cities whose growth is primarily affected by No. 5 consider Le Havre and Bordeaux in France; Danzig; Bremen and Hamburg, in Germany; Montreal, Quebec, Halifax, and St. John, in Canada.

No. 6 is a condition which is more industrial than commercial in its effect. Consider Ottawa, Hull, Niagara Falls, in Canada; Rochester, Lowell, Patterson, and Minneapolis, in the United States.

No. 7. In Europe, Moscow; in Canada, Edmonton, Saskatoon, Winnipeg are all examples.

No. 8. Kimberley, Johannesburg, Scranton, and Pittsburgh may be considered typical.

No. 9. In Canada, Vancouver, Victoria, and Halifax; in the United States, New York, Boston; in Australia, Sydney, Melbourne and Brisbane.

Agriculture.

The Cereals. All the plants which are classed as cereals are members of the grass family. They have been cultivated for food purposes since the beginning of Agriculture. Their chief value as a food lies in the starch, gluten, oils and other elements of nutrition, which they build into their seeds as food for the young plant. This food is equally well suited to man and to many animals. There are a very large number of cereals

cultivated by man for food for himself and his animals. The principal ones entering into world commerce are wheat, oats, barley, corn, rice, buckwheat, and rye.

80. WHEAT—

(*a*) *Soil and Climatic Requirements of the Plant.*

Soils and topography have less direct influence on wheat production than has climate.

The best soils for wheat are loams and those light clays which are not of a very stiff character. They must, of course, contain the necessary elements of plant food. Prairie soils usually have a high humus content and yield wheats with a heavier protein value than those grown in lighter soils. Good wheat land is usually of a moderately rolling character. This ensures good drainage, and also allows easy tilling and harvesting by field machinery. Climate is essentially the controlling factor in wheat growth. Wheat may be sown either in the fall or the early spring according to the climatic conditions. Alternate spells of thawing and freezing kill the young plants, while the warmth induced by a covering of snow is the most favorable condition possible for winter wheat. The heads of the grain attain their finest quality in dry, sunny summer weather. *The Statistics of Agriculture, Tenth U.S. Census,* gives the following as the ideal climate for wheat: "A long and rather wet winter, with but little or no frost, prolonged into a cool and rather wet spring, which gradually fades into a warmer summer, the weather growing gradually drier as it grows warmer."

Wheat is essentially a product of temperate regions. Most of the world's wheat is grown in regions of relatively dry climate; the seasonal distribution of the rainfall being of more importance than the actual amount, since this may be amplified, if necessary, by irrigation.

(*b*) *Extension of the Wheat-growing Areas—*

The demand for more wheat is becoming more insistent each year. This demand is more often not met than met. The result is that great attention is being paid to the extension of the wheat areas of the world.

There appear to be three principal methods which together offer a possible solution of the problem:

(1) To develop new varieties of wheat which are adapted to particular uses and environments.

(2) The invention of the gradual reduction process of milling spring-sown wheat.

(3) To improve and extend the transportation facilities.

Development of New Varieties of Wheat—

This seems to offer very enticing prospects. To this end Agricultural Experiment Stations, University Faculties of Agriculture and many individual workers are busy applying

the law of heredity (discovered seventy years ago by Gregor Mendel), to the making of new types of wheat. Plant explorers are scouring the world for plants that are well adapted to particular uses and environments.

In Alberta, the Provincial University is making great progress in the production of an early ripening wheat, which it is expected will push our own wheat belt much farther north. Further information on this interesting and most important topic may be obtained from High School Agriculture and Biology texts, reports of the Dominion Experimental Farms, etc.

Invention of the Gradual Reduction Process for the Milling of Spring-sown Wheat—

This invention has played a great part in the northward extension of the wheat fields of this continent. Until its introduction the hard wheat of our prairies was so brittle that it could not be milled into a decent flour. This process, however, has made it yield the most prized of all the flours and given a great impetus to wheat-growing in Canada. The introduction of this method of milling into the Siberian wheat-growing areas, with the co-operation of stable government and good transport systems, will no doubt similarly cause a northward expansion of the wheat belt in Russia.

Improvements of Transport Systems—

The volume of wheat and other grains produced in many countries now runs into many thousands of car loads annually. This constitutes a transportation problem of surpassing difficulty. In order to handle this vast volume of material special methods of handling and storing have been devised and are still being improved upon.

As the handling of the grain movement becomes more efficient we may look for a greater penetration of the wheat belts inland from the sea-boards of the continents. Canada is well in the van of this movement. Winnipeg is today the world's greatest primary grain market. Further information as to Canadian facilities for the handling and transport of grain can be obtained from the publication *Canada—Natural Resources and Commerce,* published by the Natural Resources Intelligence Service, Department of the Interior, Ottawa (single copies may be obtained free upon request).

(*c*) *The Important Wheat-producing Countries—*

In order to make just comparisons as to the relative importance of wheat-producing countries it is necessary to take the average of several years' crops. Appended is the list of countries producing an average of at least one hundred million bushels of wheat for the five-year period 1917 to 1921. The figures have been obtained from *The Year Book of Canada for 1924* (the latest officially published figures), the original source being data published by the International Institute of Agriculture.

AVERAGE WHEAT PRODUCTION FOR THE FIVE-YEAR PERIOD, 1917-1921.

Country—	Bushels	Av'ge yield per acre
1. United States	834,806,000	13.7 bushels
2. British India	330,885,000	11.2 "
3. France	249,166,000	19.9 "
4. Canada	236,025,000	12.8 "
5. Argentina	192,752,000	11.9 "
6. Italy	166,368,000	15.0 "
7. Spain	138,279,000	13.4 "
8. Australia	102,264,000	11.9 "
Total	2,250,545,000	

The world's average annual yield of wheat for this period was 3,652,669,000 bushels, and was produced by 45 different countries. Since the above eight countries were responsible for 2,250,545,000 bushels of this yearly average they may justly be considered the principal wheat-producing countries.

These figures, however, do not include Russia. At the present time Russia, sorely tried by her internal dissensions, is no longer listed among the agricultural nations of the world. It must not be forgotten, however, that Russia is a great agricultural land, and will eventually take her accustomed place as one of the leading wheat lands of the globe. During the three-year period 1909-1911 Russia was second only to the United States as a wheat producer, having a yearly average of over 619 million bushels against the United States' average of over 646 million bushels during the same period. It is this withdrawal of the Russian wheat contribution from the world's markets which has given such a great stimulus to wheat-growing the world over.

(d) The Important Wheat-importing Countries—

The chief wheat-importing countries are the manufacturing nations of Western Europe. It must also be remembered that the whole of the United States lying east of the Appalachian mountains is a great wheat-importing region. This fact is very likely to be missed in a study of international statistics only. The consultation of the domestic statistics of the United States will show that this region is dependent upon the interior lands for its wheat supply. It is the rapid extension of this great industrial region that is so quickly changing the United States from a wheat-selling to a wheat-purchasing nation.

The greatest wheat-purchasing nation is Great Britain. Other large international purchasers are Germany, France, Holland, Italy, Switzerland, Norway and Sweden.

(e) The Chief Wheat-exporting Countries—

The fact that a country is a large producer of wheat does not always mean that it is a large exporter of wheat. It is not

mere production which counts, it is the surplus. For example, in 1923, the United States produced 28% of the world's crop of wheat, while Canada produced only 14%, or half the amount produced by United States farmers. In the matter of exportation, however, Canada supplied 40% of the wheat entering into the world's markets, whilst the United States quota was 26%. Again, Europe normally produces about 50% of the world's wheat supply, but her dense population consumes about 60% of the world's total crop. The following statistics should prove useful in the study of the geography of wheat:

World's Wheat Production 1923.	
United States	28%
Canada	14%
British India	10%
France	9½%
Argentina	8%
Italy	6%
Spain	5%
Roumania	3⅗%
Great Britain	3%
Germany	2.9%
Rest of the World	10%

World's Wheat Exportation 1923.	
Canada	40%
United States	26%
South America	24%
Rest of the World	10%

(*f*) *Principal Causes of the Low Average Yield in the Great Wheat-exporting Countries*—

British India and Australia are both strongly influenced in this respect by the fluctuations in the rainfall, both these countries being subject to frequent droughts. In British India this is being overcome by great irrigation works. Some of the largest irrigation projects in the world have been or are being constructed there, the widely boosted American projects paling into relative insignificance when compared with them. Australia is endeavoring to counteract the deficient rainfall with irrigation supplied from artesian wells.

Crude farming methods are employed in Russia and the Argentine, the latter country being also subject to great crop losses from locusts.

Abundance of summer rain induces rust and other fungus diseases in wheat.

In Canada, the Ontario and Manitoba wheat fields are the greatest sufferers from rust.

Another insect pest that does a fearful amount of damage is the wheat-stem sawfly.

For information regarding these in Canada write the Department of Agriculture, Ottawa, for its pamphlets.

(*g*) *Factors Influencing Cheap Production Are*—

(1) Cheapness of land.
(2) Cheapness of labor.
(3) Extensive use of tractors and other farm machinery.

The first operates in Canada, Argentina, Russia and Australia. The second in India, Egypt and Russia. The third condition is best developed in the United States and Canada. The Argentinians are rapidly improving in this respect.

(h) Comparison of Position of Wheat-exporting Regions with Respect to the Cost of Transportation to World Markets—

In this respect Russia enjoys the most favorable situation, and for the following reasons:

(1) Her wheat fields are nearest the great purchasing nations of Western Europe.

(2) The major portion of the haul is naturally accomplished over the sea.

(3) The Russian wheat lands are traversed by fine navigable rivers which empty into seas open the year round.

(4) Of these rivers the Dneiper, Bug and Dneister empty into the Black Sea within a few miles of the great port of Odessa, while the Volga valley is connected by rail to Novorossiysk from the great easterly bend of that river at Sarepta.

After Russia, the Argentine Republic has the finest natural position. The factors contributing are:

(1) The wheat fields reach down to the sea.

(2) They are penetrated by the magnificent inland waterway of the La Plata estuary and its tributary river, the Parana.

(3) The railroads of the country. Argentina ranks ninth among the nations in point of railroad development.

(4) The splendid grain-handling facilities at her great ports of Buenos Aires, Rosario, and Bahia Blanca.

(5) Ocean transport is the major portion of the haul.

Canada and the United States labor under the following disadvantages:

(1) Their great surplus-yielding wheat areas lie in the heart of the continent, a thousand and more miles from their seaports.

(2) The railroad haul is greater in these two countries than in any other region.

(3) The great natural waterway, the St. Lawrence, and the Great Lakes system is, owing to climatic conditions, only available for part of the year.

(4) Canada's greatest port is ice-bound part of the year.

(5) The Pacific ports have not yet been developed as grain-exporting centres to any extent.

To offset these great disadvantages there may be shown the following advantages:

(1) The wheat fields are nearer the great purchasing nations of Western Europe than any other, excepting those of Russia.

(2) The railroad and grain-handling facilities are far better developed than in any other part of the world.

(3) The cheapness of the Canadian railroad freight for grain.

(4) The high quality of the Canadian wheat.

For further discussions of this problem from the Canadian point of view, consult the booklet *Canada—Natural Resources and Commerce,* published by the Department of the Interior.

India is favorably situated for ocean transport but her great wheat lands lack the magnificent railroad and storage and mechanical facilities of Canada and the United States.

Australia is heavily handicapped by her remote position.

(*i*) *Future Wheat Supply—*

There is little doubt that the next decade will see the United States transferred from the status of a wheat exporter to that of a buyer. Already her public men are calling attention to this fact. This must inevitably result in Canada and the Argentine Republic becoming the two leading lands in wheat exportation. They both have sparse populations and great fertile areas suitable for wheat production.

With regard to Canada, Dr. Saunders said in 1904 that wheat grown on a quarter of the land suitable to it in the Canadian North-West with the acre yield of Manitoba for the preceding decade, would yield a crop of more than 800 million bushels. This, he shows, would feed a population of 30 millions in Canada and still leave a surplus great enough to supply the import needs of Great Britain three times over.

British India has vast potentialities as a future wheat-producer. This is true both from the point of view of cheap labor supply and of available land. Siberia, as the demand for wheat increases, will also be a future contributor. Manchuria is also a coming wheat region. The Chinese and Japanese are gradually changing from rice-eaters to wheat-eaters. As their use of wheat increases Siberia and Manchuria will rise in importance as wheat-producing regions, for they are the natural sources of supply for these Oriental populations.

(*j*) *Flour-milling: Location of Chief Centres, and Factors Contributing to Their Development—*

During the last quarter of the nineteenth century great changes were made in the methods of milling wheat into flour. Prior to 1881 all commercial flour was made in grist mills. Today the grist mill has practically disappeared. Its place has been taken by the roller mill. This substitution of rollers for mill-stones marks the most radical advance ever made in the history of milling. It made possible the operation of large flour mills and therefore ushered in the large scale production of flour. The Hungarian millers appear to have been the first users of the roller mill. They used rollers made of hard porce-

lain. During the last quarter of the nineteenth century Hungarian flour, produced by this method, led all the others in purity, uniformity of grade, and keeping qualities.

American millers visited Hungary in order to study their milling methods. The result was that Hungarian roller mills were shipped to Minneapolis. Here the roller mill was further improved to meet the new conditions required by the appearance of the hard wheats. Hardened steel rollers were added, and improvements made in screening and bolting methods. The wheat was gradually reduced to a flour and the germ and bran coats more perfectly removed. This later modification of the Hungarian roller milling process is what is now known as the gradual reduction process.

Vulte and Vanderbilt, in their book *Food Industries,* give the following comparison between the old grist mill processes and the modern methods:

Disadvantages of the Old Processes—

(1) They were very slow.
(2) The flour could not be ground as fine.
(3) Friction caused by heat which affects enzyme action. Starch would be changed to a more soluble form, thus making the flour more liable to be spoiled by molds and bacteria.
(4) The keeping quality of the flour was very poor. This was due partly to the liability of enzyme action just mentioned and also to the fact that the germ could not be removed.

Advantages of the New Process—

(1) Increased capacity due to greater strength of the parts and consequently greater speed of revolution.
(2) Much less power is required to run the machinery on account of the lesser weight of the parts.
(3) The present-day process is much cleaner. All foreign matter is removed in different siftings, brushings and washing. The purifier shows marked progress in cleansing. From the time that the grain enters the mill until it is ready for shipment as flour, the human hand does not touch the wheat. It is carried from place to place, from process to process, entirely by elevators, conveyors, and other mechanical devices.
(4) The separation is much more perfect, only the parts which are desired are found in the flour.
(5) It is more economical as there is less waste.
(6) The rollers do not touch, so that small particles of steel are not often found in the flour. Should there be any, they can be removed by passing the flour through a magnetic zone.
(7) Modern flour keeps better, the germ has been removed, and there is less heat by friction, so fewer undesirable changes take place.

From the above it will be seen that modern flour milling is a very complicated mechanical process requiring large plants and ample supply of power. Flour is the staple food of the populations in industrial regions. This necessitates cheapness in production in order to place it within the purchasing power of these people. The by-products of the milling processes are valuable foods for the animals raised for human needs, but the low price at which they must be sold forbids heavy transportation costs. Therefore we see that the following factors operate in determining the locations of the chief milling centres.

(1) An ample supply of cheap power must be available. The cheapest form of power production is water power, used either as hydro-electric or by direct application.

(2) They must be located at centres of transportation near the region of wheat production, or

(3) At places where a well organized and efficient transportation system can deliver the wheat to the mill at a low cost and distribute cheaply and efficiently the final products.

(4) Proximity to a market which will absorb the by-products, viz.: shorts, bran, middlings, etc., produced during the process.

Examples of the operation of these factors are seen in the following typical cases. The location of the Minneapolis milling industry is governed by the power obtained from the Falls of St. Anthony, and by its situation at a centre of transportation in a region of great wheat production.

In the case of Port Colborne, Ontario, which has the largest flour mill in the British Empire, the third factor, situation on a well organized and efficient transportation route, etc., is the governing factor.

Winnipeg, which has also a great milling industry, shows the effect of factors 1, 2 and 4.

Buffalo, New York, shows the same influences as Port Colborne. The lack of the fourth factor often handicaps a milling industry. This is well shown in the case of Shanghai. The lack of domestic animals in China prevents the millers of that city from completely disposing of their by-products. They must, therefore, charge more for their flour, or else be content with a very much diminished profit.

Factor No. 2 is the chief influence in determining the location of the British milling plants, since they are almost completely dependent upon imported grain.

Disposition of By-Products—

The principal uses of by-products from the milling industry are as food for fattening the animals used for human foods and in the dairying industry. Large quantities are also used in the preparation of the popular cereal foods, which are so rapidly displacing oatmeal on the breakfast table.

Additional Information Useful in the Geographic Study of Wheat—

The great wheat-exporting ports of the world:

North America—New York, Montreal, Portland (Maine); Seattle and Vancouver are ports on the Pacific coast which are increasing in importance as wheat exporters since the opening of the Panama Canal.

Europe—Odessa, Novorossiysk and Galatz.

South America—Buenos Aires, Rosario and Bahia Blanca.

Asia—Karachi, Bombay and Shanghai.

Africa—Cairo and Alexandria.

Australia—Adelaide, Melbourne and Sydney.

Relative Cost of Transporting Wheat on Canadian Routes—

Western rail and ocean route, 37 cents per bushel.

Eastern lake, rail and ocean route (summer only), 47 cents per bushel.

Eastern rail and ocean (winter route), 48 cents per bushel.

Relative Distances along Canadian Transportation Routes to Liverpool—

	Water miles	Land miles	Total miles
Western rail and ocean	8,580	769	9,349
Eastern lake, rail and ocean	4,060	1,235	5,295
Eastern rail and ocean	2,465	2,971	5,436

Relative Costs of Wheat Transportation Methods—

Wagon	30	cents	per	ton	mile.
Motor truck	15	"	"	"	"
Rail	65	"	"	"	"
Canal and lake	03	"	"	"	"
Ocean	01	"	"	"	"

81. Oats. In soil and topographical requirements the oat plant is similar to the wheat plant. It requires a cooler climate and a greater abundance of moisture. It is, therefore, better suited to a colder region than wheat. Heat without moisture is a condition not at all suitable to the growing of oats. The Mediterranean type of climate (hot, dry summers with wet winters), which suits wheat so well, is not at all suitable for oats. Oats are, therefore, important crops in cold, damp countries like Ireland, Scotland, Norway, Sweden, and New Zealand. They are also important in Eastern Canada and the northern edge of the Prairie Provinces since they are not so easily injured by light frosts as wheat is.

In lands having hot moist summers they replace wheat as a crop, since they are more resistant to rust and other fungus diseases than wheat would be under these conditions.

In the corn belt of the United States oats form a very important grain crop. This is because the climatic requirements

of the plant enable it to dovetail nicely with the hay and corn crops of the region. In lands which are frost-free during the winter season a winter variety of oats is often raised. Such regions are all the South-Eastern United States excepting Florida, and along the United States Pacific coast.

Oats are a widely distributed crop. This is due to several facts, but principally to two:

(1) They are too bulky to bear the cost of long distance transportation, hence they are usually grown near the district where they will be used.

(2) No other feed seems to give horses so much energy as do oats.

Therefore they are grown on many farms at a cost which would be financially impossible if they were to be sold at market prices. Oats, therefore, whilst they form a large proportion of the domestic trade in grains, do not bulk very largely in international commerce.

Oats rank third in value among Canadian field crops. In Ontario and Quebec the large acreage and production of oats bears an important relationship to the cattle, bacon and dairy industries of those provinces.

Uses—The principal use of oats is as feed for stock. Oats are also extensively used by man as a breakfast food in the form of oatmeal or rolled oats. This is the form in which oats largely appear in export trade.

82. Barley. This is the hardiest of the important cereals. Its short growing season and frost-resisting characteristics enable it to be grown in high latitudes. It ripens under the rays of the midnight sun in Lapland, and is regularly grown in Finland nearly up to the shore of the Arctic Ocean. It is equally important in hot desert countries like Abyssinia, Sudan and Somaliland, because of its ability to resist drought and heat. It is principally grown for malting, human food and stock feeding. Barley forms an important part of the diet of the laborer of England, Asiatic Turkey and North Africa.

Russia is normally the world's largest barley producer, the United States being next.

Uses—If it were not for its shortage of gluten, it is highly probable that barley would replace wheat as the principal bread cereal; its hardness and prolific yielding powers making it less dependent upon climatic and soil conditions than wheat.

In the past it was the chief grain food of the ancient Greeks, Romans and Hebrews, who were rather densely settled in lands having dry summers. Even today it is the principal breadstuff in Norway and Sweden, Russia and Germany. Its present use is mainly for brewing and malting and the feeding of stock. The principal exporters of barley are, in order of value: Russia in normal times, the Netherlands, Hungary, India, Roumania, the United States, Canada.

The principal importers are Germany, Great Britain, the Netherlands (mostly re-exported), Belgium, France.

83. Corn. This is the only cereal native to North America. The geographic range of corn is strictly limited by temperature and rainfall conditions.

Soil requirements.—The best corn soils are well drained, deep, warm, black loams with a high percentage of organic matter and available nitrogen.

Climatic requirements.—Corn is a warm climate crop. It is very sensitive to frosts and must have sufficient rainfall during the summer to keep up the growth of the plant. Its heat requirements are such that it must have both warm days and warm nights. It appears to require an annual rainfall of not less than 20 inches with a marked summer maximum. Corn does not thrive in regions of cool cloudy summers, even if their rainfall is sufficient. The United States is the greatest producer of corn in the world. Mexico and Ontario are also important producers. After the United States, the Argentine Republic is the greatest producer and will continue to increase in importance as the country becomes more settled and its corn belt is given better inland transportation. South Africa has in later years made great strides in the production of corn and the Union Government is fully alive to the possibilities of corn production. During the last five years the South Africans have installed many concrete elevators and are rapidly bringing their methods of handling to a high degree of efficiency.

At the present time the United States, Mexico and Canada produce about 75% of the world's crop of corn.

Corn in Canada, excepting in the Province of Ontario, is mainly grown for ensilage or to feed green to cattle. The climatic conditions of Canada will never allow her to become a great grower of corn for the grain.

Uses of Corn.—Every part of the corn plant is used in some form or other. The young ear is used as human food. The husks are used to make mattresses, mats, etc. The leaves are fed to cattle and poultry; they are also made into paper stock; and they are returned to the land as fertilizer. The pith of the stalk is made into cellulose and is also used for packing between the double hulls of warships, because when it absorbs water it swells up and closes the hole made by projectiles. The whole stalk is used for ensilage or fed direct to livestock. The grain is used for brewing, distilling whiskey, alcohol, eau-de-cologne, etc. Starch is obtained from the seeds and converted into gum (dextrine), corn syrup, glucose, grape sugar, caramel. It is also used directly as food.

The germs of the seed are made to yield corn oil and oil cake. The milling of the seed also yields corn meal, bran and gluten. The cobs are used for fuel and also for smokers' pipes.

The United States Department of Agriculture gives the following disposition of the average yearly corn crop of nearly three billion bushels of corn during the period 1912 to 1921.

The Uses of Corn—

Fed to hogs on farms	40%
Fed to horses and mules on farms	20%
Fed to cattle on farms	15%
Fed to poultry on farms	4%
Human food on farms	3½%
Fed to sheep	1%
Fed to stock not on farms	3½%
Ground in merchant flour mills	6½%
Exported	1½%
Other uses	3%

It will be seen from the above that more than three-quarters of the entire crop of corn in the United States is used to feed farm animals.

Future Supply—With the rapidly changing character of American industry even this small proportion of the American crop of corn must soon disappear from the world's trade. The United States will then become a buyer of corn, notwithstanding her huge production. This will bring the Argentine and South African corn more into demand. These countries seem destined to be the principal sources of supply in the near future.

84. Rice. Rice is the great food crop of the Orient. It forms the staple food of one-third of the human race. The chief regions where it is cultivated are in South-Eastern Asia. The only other regions producing notable quantities are Egypt and low-lying swampy land in the southern United States and Italy. South-Eastern Asia, including Japan, produces about 95% of the world's crop of rice.

Rice is not a bread grain, its lack of gliadin being a serious deficiency in this particular. It is poorer in protein and fat than other cereals, but much richer in starch. Oriental peoples remedy this deficiency by supplementing their rice diet with legumes, fish and other nitrogenous foods. Its lack of fat and protein, however, gives it its excellent keeping qualities in hot, humid climates. Many varieties of rice are grown in the Orient, but they all belong to two general classes, viz.: "hill rice" and "swamp rice." The latter class is the more important. Rice is very exacting in regard to the geographical conditions necessary for its growth.

The important condition requisite for rice cultivation is availability of water. Swamp rice must be flooded when it is germinating. It also requires flooding at frequent intervals during its growth. For these reasons the water supply and the topography of the land are of very great importance in determining the suitability of land for rice cultivation.

Swamp conditions are, therefore, essential to the successful growth of the plant. It is found that from 45 to 65 inches of water must be supplied to the plant during its growing period. In the monsoon lands of South-Eastern Asia this is supplied naturally by the abundant summer rainfall. In the United States the rainfall in the rice region is only 20 inches, the balance being supplied by irrigation. Some rice is grown in California, where 60 inches of irrigation water is necessary. Level fields are also essential to rice production. The flooded land must have a uniform depth of water. This condition is unattainable on rolling land. In the Orient the hillsides are terraced to produce, artificially, this requirement of levelness of the fields. The lands which naturally have this level feature of their surface are delta lands, hence rice is pre-eminently a delta crop.

Rice is a slow growing crop, requiring in general from 180 to 200 days to come to maturity, although there are a few varieties which will attain maturity in 150 days. This means that a temperature of from 60° to 80° F. must be maintained for six months. This requirement definitely prevents rice from being grown extensively in other than tropical or sub-tropical regions.

Soil requirements.—Rice is grown on a variety of soils. Their suitability for the purpose depends largely upon their ability to hold irrigation water.

The most favorable condition is found when a friable loam overlies a heavy clay. The upper layer admits of the free root development of the plant, while the clay prevents under-drainage and holds the water which is so essential for rice-growing. Coastal lowlands and river deltas are usually found to have such soil conditions.

The evidence of the favorable nature of all these conditions to rice-growing is shown by the importance of the rice crop on the deltas of the Ganges, Brahmaputra, Irrawaddy, Mekong, Yang-tse, Nile, Po and Mississippi Rivers.

Another reason for the restriction of rice cultivation to monsoon lands is an economic one. The labor of planting and transplanting fields of rice is incredible. This can only be cheaply accomplished in two ways, viz.: by cheap labor or by machinery. The small size of the fields due to the requirement of levelness prevents the extensive use of rice-planting machinery. The large scale planter is, therefore, compelled to fall back upon a cheap, plentiful labor supply. This is only obtainable from the crowded populations of the monsoon lands.

The principal rice-producing countries are India, including Burma, the Dutch East Indies, Japan, Siam, the Philippine Islands, Chosen and Taiwan. China grows immense quantities. Since none of it enters into world commerce, as it is all consumed locally, it is not possible to say what the Chinese production really is, but it is known to be greater than that of any other country.

India has little rice for export; China, Japan and the Dutch East Indies have none.

Burma, French Indo-China and Siam are the great exporting countries for rice.

Rangoon at the mouth of the Irrawaddy River is the greatest rice port in the world. The Dutch East Indies, Germany, Ceylon, the British Isles, the Netherlands, Japan, China and the United States are the greatest rice importers.

Wheat and rice are the two most important raw food products entering into world trade. No other unmanufactured commodity can begin to approach them in value.

85. Buckwheat. Although not a member of the botanical family of grasses, buckwheat is usually regarded as a cereal, because of the use we make of its seeds. Its principal use is for feeding poultry. Flour is also made from it. It is cultivated in Russia, France, Japan, Canada and the United States. The plant is believed to be a native of China. Buckwheat is a profitable crop on lands too poor to produce most other crops. It does best on moderately fertile, loamy, well-drained soils. It grows so quickly that it may be grown as a catch crop after some other crop has failed.

It is a suitable crop for rugged regions. Buckwheat is relatively unimportant in foreign commerce.

86. Rye. Rye has been called the "grain of poverty" because it will grow on soil too poor for the successful production of wheat, barley or corn. It is most extremely cultivated in Europe, where it is also most abundantly consumed. Ninety-five per cent. of the total rye crop of the world is grown and consumed in Europe. It has the greatest relative importance as a crop in Germany, the Netherlands, Russia, Belgium and Hungary. In Russia the rye crop is in normal times about equal in importance to the wheat crop. Of the other countries mentioned only Hungary produces more wheat than rye. Rye is the principal bread cereal of Russia and Central Europe, where it is used to make the common black bread of the common people. It does not enter very largely into world commerce. Its principal use is to make rye bread and for distillation for the production of whiskey.

87. Starch Foods. Starch is an essential constituent in the diet of man and other animals. Its function in diet is to produce energy and body heat. Starch is really the surplus food stored by plants in seeds, stems, tubers, leaves and roots for their own needs or for the young plant. No animal is capable of manufacturing and storing starch directly, but must obtain it indirectly from the plants. Among plants only those possessing chlorophyll are capable of building up starch. This is accomplished by means of what is known as "Photosynthesis." See Caldwell and Eikenberry, *General Science*, pages 80-86.

For this important article of diet, therefore, we are dependent upon plant life. The principal sources of starch are the potato, banana, sweet potato, tapioca and sago.

88. The Potato. Excepting wheat and rice, the potato is the most important raw material entering world commerce for food. The plant is a native of America, whence it has been taken to almost every part of the world. It forms the great starch food of the temperate regions of the world, as the banana forms the great starch food of the warm regions.

A study of the geographic distribution of the potato shows that it does best in those regions having—

(1) A cool and uniform temperature.
(2) A moderate rainfall.

The plant does best on a soil which—

(1) Is light and friable.
(2) Has a considerable humus content.
(3) Is well drained.

The potato is subject to several diseases, which become particularly destructive under conditions of heavy rainfall and high temperatures. Over 90% of the world's crop of potatoes is grown in Europe. The potato crop of Europe greatly exceeds in volume, and nearly equals in value, the total wheat yield of the world. Four European countries, viz.: Germany, Russia, Austria and France each grow more potatoes than the United States and Canada combined. The combined production of the continent of Europe is nearly ten times that of the whole North American continent.

Although in normal times Russia has the larger acreage, Germany leads the world as a producer of potatoes. About 14% of the cropped land of Germany is in potatoes. The Germans use the potato largely for stock feed, nearly half of the crop being used to feed swine. The great chemical skill of the Germans enables them to use about 10% of the crop industrially. From potatoes they make industrial alcohol, potato flour and potato flakes and starch.

In Canada the potato crop in 1923 was valued at $56,397,800. The average value of the Canadian potato crop for the five years 1918-1922 was $96,680,080 and was obtained from an average acreage of 744,801 acres.

The following table shows the average production by provinces for the same five-year period:

Province	Acreage	Value
Quebec	263,894	$38,338,200
Ontario	163,591	18,950,640
New Brunswick	72,173	10,217,960
Nova Scotia	48,124	7,922,800
Saskatchewan	58,796	6,728,780
Alberta	45,395	4,765,940
British Columbia	17,337	3,095,060
Prince Edward Island	35,315	3,051,040

Of the 1923 crop $1,887,075 was the value of Canadian potatoes exported from Canada, chiefly to the United States.

On account of the great bulk and weight of potatoes in proportion to their value, and because of their perishable nature, they do not bulk largely in international commerce in the raw state. The bulk of the potato crop must therefore be produced near the markets where it is consumed. Large cities are the natural markets for the potato. This accounts for the relatively large acreage under potatoes in Eastern Canada. The surplus is easily absorbed by the greater Canadian cities and those of the Eastern United States. Elsewhere in Canada the crop is consumed locally as food for humans and animals, or else converted into starch. In this latter form it may be transported great distances.

89. Bananas. The banana is the great staple food of millions of people in the tropical regions of the world. It is stated that one pound of banana fruit is equal in nourishment to three pounds of meat, and that the same area that will yield 35 pounds of wheat or 100 pounds of potatoes will grow 4,000 pounds of bananas. The banana-tree is the most wonderful and prolific food-manufacturing machine in existence. No other plant yields so much food for so little cultivation. The tree has been cultivated so long that it no longer produces seeds. It propagates by means of shoots from the roots. All that is necessary to obtain a crop is to detach these shoots and stick them into the ground. Then, if other vegetation is prevented from crowding out the young plants, a banana plantation results. These plantations continue bearing for years. Ploughing is not necessary. Tilling is almost unknown. Contrast this with the elaborate ploughing and cultivation necessary to obtain a satisfactory crop of potatoes. Those who only know the banana as a fruit have little conception of its value as a food to the natives of the equatorial lands. There it is the substitute for the bread, potato and rice of the Europeans, Americans and Chinese. It is usually eaten cooked. Scores of varieties are grown. These are of great variation in size and flavor. They are all, however, great sources of starchy food. The banana enters into world commerce quite largely. Owing to its perishable nature it has only recently become a common article of food in the temperate zone. Today, with the advent of quick transportation and refrigeration, the banana is shipped from its native home to the great cities and towns of the industrial regions of Western Europe and North America. It competes with the home-grown fruits, with the potato, and also with the cereals. Europe is supplied by fast steamers from the Canary Islands and the West Indies. Canada and the United States draw their supplies from the West Indies, the Caribbean lands and Central America. So great is the value of the banana to these lands that $1,000 per acre is a common price for banana land in the Canary Islands.

Boca-del-Toro, in Panama; Himon, in Costa Rica; Puerta Barrios, in Guatemala; Port Antonia, in Jamaica; Santa Marta, Colombia and other Caribbean ports have all recently become very active ports owing to the trade in bananas with North American cities. As an instance of the stimulating effect of the banana trade in this region consider Jamaica. In 1869 the total fruit exports from that island were valued at $15,000; in 1879, $350,000; in 1899, $4,000,000; in 1909, $7,500,000; and they are still increasing.

Practically all this increase is due to the increased demand for bananas in the temperate lands of Western Europe and North America.

The banana does not seem to be much affected by plant diseases, but the crop may be badly damaged by wind. Some of the islands of the West Indies lie in what is known as the hurricane belt. Here the fierce storms often work great destruction among the banana plantations. The heavy burden of fruit added to the weakness of the stems, and the great size and fragility of the leaves, make the tree peculiarly vulnerable to destruction by high winds.

90. Sweet Potato. Sweet potatoes are not tubers like the white potato, but are the fleshy roots of a tropical plant. They also differ from the white potato in that they thrive best in the heat and humidity of the long southern summers. They are of great importance as a starch food in the tropics. They supply the natives of the tropics with a food similar to the potato but providing in addition a great amount of sugar and nourishment. Some varieties are called "yams." These grow very large and often attain a weight of from 40 to 50 pounds each.

The sweet potato requires a lighter and sandier soil than the white potato. It is, therefore, largely grown on the sandy lands of the Atlantic coastal plain in New Jersey, Maryland and Virginia. These American centres produce the sweet potatoes which are offered for sale in Canada and the Northern United States. The sweet potato is also grown in the Southern United States for local consumption. There it provides an alternative article of diet to rice as the chief starch food in addition to corn bread.

91. The Legumes. The legumes are a botanical group characterized by their ability to gather nitrogen from the atmosphere, and by the production of their seeds in pods. This nitrogen they obtain by the assistance of colonies of bacteria, which form tubercles on their roots. Part of the nitrogen thus obtained is left on the roots and so enriches the soil. Part of it is stored up in the seeds in the form of protein. Protein is one of the absolute essentials in diet. It is the part of the food which makes body tissue, and provides material for growth and the repair of body waste. Legumes are, therefore, meat substitutes. In densely populated lands like China and India, they form the chief source of supply for the protein element in diet.

Leguminous plants are of great variety, ranging from such humble plants as clovers up to large trees.

The fact that the legumes furnish so many kinds of food and fodder plants, taken with their importance as fertilizing crops, makes them one of the most important of all the economic plants. Peas, beans, lentils and peanuts are the legumes most generally used for human food. Clovers, vetches, peas, beans and alfalfa are the principal ones produced for animal fodder.

92. Peas. There are many varieties of peas. The field peas and the cow peas are the ones which are most grown. In India, China and other Oriental lands the cow pea is used for human food as well as for animals. In the western lands it is mainly a fodder or fertilizing crop.

Canada field peas are an important Canadian crop. They thrive best in a cool climate and on a well drained soil, especially such heavy soils as clays and clay loams, which are well supplied with lime. They are also extensively grown around the Great Lakes region in the United States. The greater part of the crop is harvested for grain which is fed to live stock, but some is used for human food and enters into commerce in the familiar form of split peas. The rest of the crop is cut either for hay or silage.

The value of the peas entering into the market as grain from Canada in 1924 was $5,676,000.

93. Beans. Dry, edible beans are one of the most important minor crops. Beans will grow on a great variety of soils, but do best on a moderately fertile soil derived from limestone rocks.

They are grown in rotation with other crops, usually wheat and clover. They form an important article of human diet, especially in those lands where meat is expensive. Some varieties form an important food for horses. The greater part of the Canadian crop is grown in Quebec and Ontario. The average annual value of these two provinces during the five-year period 1918-1922 was $6,336,920.

94. Peanuts are the underground pods of a legume grown in the Orient, Africa, Mediterranean Europe and the Southern United States.

In the United States the commercial crop has a value exceeding 18 million dollars.

Peanuts are used for human food, and for feeding livestock. The vine after the nuts have been removed makes a valuable hay. In the Southern United States hogs are often turned into the fields to eat up the crop, instead of harvesting it. Experiments show that pork can be produced in the South in this way as cheaply as in the corn belt.

Peanuts are especially valuable for their fat content. Considerable quantities of peanuts are converted into peanut butter

and peanut oil and marketed in this way. Much of the African and Indian crop is used up as a fat for soap-making at Marseilles.

95. Clovers. These are all either used as a fertilizing crop or else fed to live stock as fodder. They form a very important animal food stuff. Every province in Canada grows more or less clover, but the Prairie Provinces sadly feel the need of a clover which will survive the winters. Much effort is being put forth to develop a clover which will not winter-kill. At present the "Altaswede" clover seems to give great promise. (Particulars may be obtained through the Department of Extension, the University of Alberta, Edmonton.)

Clovers are chiefly valuable as a hay crop. The hay crop of Canada is very important in connection with the dairy industry. Part of it is also exported to Europe. The hay crop of the Dominion is second in value only to the wheat crop:

In 1924	Hay and Clover	$165,587,000
	Alfalfa	14,705,000
	Grain Hay	46,133,000
	Total	$226,425,000

The wheat crop for the same year was valued at $320,362,000, and the oat crop at $203,034,000.

96. Vegetable, Fruit and Wine Industries. The term "vegetable" is applied by custom to a host of food materials obtained from the roots, stems, leaves, fruits and seeds of a large variety of plants.

Vegetables have long been raised for home or local consumption in the gardens of farms and on small holdings on the outskirts of towns and cities.

The commercial vegetable industry is, however, of quite recent origin. Because of the perishable nature of vegetables, and the fact that they are of most value when fresh, the development of this industry was delayed until—

(1) The invention of efficient methods of trans-shipping and marketing perishable goods.

(2) The growth of large city populations able and willing to pay for vegetables at all seasons.

(3) Increase in the price of meat.

The kinds of vegetables are so numerous that it is impossible to make any general statement of climate and soil requirements. These are really minor factors in the vegetable industry, since, if people are willing to pay the price, artificial climates and soil conditions may be obtained. An example of this is the growing of tomatoes, early lettuce, etc., under glass. In the case of

the vegetable industry economic conditions are the chief factor, geographic conditions being only secondary.

97. There are three systems by which vegetables are produced, viz.:

(1) Home gardening.

(2) Market gardening.

(3) Truck farming.

The first requires no explanation.

Market gardening is the growing of vegetables and small fruits for sale. The produce is generally marketed in large cities. The great market for vegetables is always the city. The conditions of city life make it axiomatic that "the larger the city the greater the market for vegetables." This results from the following economic considerations:

(1) The high price of the land in cities forbids areas being devoted to agriculture.

(2) City dwellers have not sufficient time to devote to vegetable-growing.

(3) The higher taxation in cities would eat up the profits.

(4) City dwellers receive a large enough cash income to pay for the service of raising and delivering their vegetables.

This results in market gardeners concentrating around great cities because—

(1) The haul is shortened.

(2) The produce may be delivered while still fresh.

(3) The cost for packing is reduced.

(4) The fluctuating demand for labor on market gardens can be more readily satisfied near the city than in the country.

(5) Fertilizers are more easily and cheaply obtained.

98. Truck Farming only differs from market gardening in matters of detail.

Truck farming regions are often situated at considerable distances from their markets. They must, however, be connected with them by efficient transportation. The truck farmer is also usually of a specialist type. That is, he will grow only a few types of vegetables, but these he will grow on large acreages. Improved railway facilities with refrigerator car services have greatly assisted the rapid development of truck farming.

The trade in fresh vegetables is a large one and incredible quantities of fresh produce are shipped distances which would have astounded the farmers of a generation back.

99. Vegetables for Canning and Drying. All vegetables consist largely of water. This makes them bulky and costly to transport, and at the same time causes them to spoil rapidly. Certain vegetables, like tomatoes, peas and sweet corn, are also available for use only during a relatively short season, especially in the North and South Temperate Zones. These conditions have led to the development of the vegetable canning and drying industries.

The commercial canning of vegetables has had the following results:

(1) It has greatly increased the total amount consumed by making them available in parts where they could not be possibly grown.

(2) It has increased the per capita amount by making them available throughout the year.

(3) It permits these crops to be grown in climates and on soils best suited to them regardless of the proximity of the market.

(4) It has provided a profitable outlet for the unmarketable surpluses of abundant seasons.

The principal vegetable canning regions of Canada are in Southern Ontario. In the United States, California, South-Western Missouri, Central Indiana, Maryland and Virginia are the most important regions.

Vegetable canning is also important in France, Spain, Italy and Germany.

100. Fruit Industries. Fruit-growing is a complicated industry, involving a wide range of products, and very unlike geographical conditions. This industry is very dependent upon biological and economic factors. Apples, pears, peaches, apricots, oranges, lemons and other citrus fruits, plums, grapes, dates, currants, raisins, pineapples, etc., are the important fruit products entering into world commerce.

101. Apples. The apple is one of the most widely distributed of tree fruits. It is grown in South-Eastern Canada, South-Western Canada, the Eastern United States, the Ozark plateau, the Mississippi Valley and the irrigated districts of the Pacific Coast States. It is also grown in Great Britain and South-Western Europe. In the Southern Hemisphere we find it in South-Eastern Australia, Tasmania, the South-East of the Cape Colony and in Chile. It is a greatly prized fruit among the Teutonic and Anglo-Saxon races. The Oriental nations do not seem to value it, since it is rarely cultivated by them, even where the climate is suitable.

The United States produces more apples than any other nation. This is the leading fruit crop produced in that country. It takes up more than half the acreage of all fruits and nuts.

Compared with the potato, vegetable, cotton or hay crops, the apple crop of the United States is relatively small.

Canada is the second most important apple-growing country in the world, the principal centres being Nova Scotia, the region near Montreal, Southern Ontario, and the irrigated valley lands of Southern British Columbia. The commercial apple regions of Europe are mainly in the North-West, where fertile soil, undulating land, mild winters and moderately warm summers, together with abundant moisture, are combined with proximity to urban markets.

The counties of Kent, Herefordshire, Dorsetshire, Devonshire and Cornwall are the important commercial apple centres of Britain. Kent specializes in table fruit, while Hereford and the others concentrate in the production of cider apples. The south-west peninsula of England is famous for the beverage made from these. Rhenish Prussia and Wurttemburg are the principal German centres. Normandy and Brittany in France and the northern coast of Spain are the respective centres in those lands. Tasmania is the chief commercial apple-growing centre of Australasia.

Apple-growing for commercial purposes is a difficult proposition since the fruit is subject to attack by a number of insect pests. These cause the fruit-grower to suffer great losses and add to the expense of production by the necessity of frequent spraying. Again, the fruit is so easily bruised in transit that packing becomes an expensive item. The finest and largest apples in the American Continent come from the Annapolis Valley in Nova Scotia and the Pacific Coast lands. The greater care in growing, grading, packing and marketing exercised by the Western growers has seriously weakened the market for the less progressive apple-growers of Ontario. This is largely because in Ontario the apple is the secondary crop, while in British Columbia and the Pacific States it is the principal crop.

102. The Peach. This fruit is, because of its perishable nature, considered more of a luxury than the apple. Its delicious quality makes it much sought after. The difficulty in marketing the peach lies in the fact that the fruit cannot be kept in good condition for more than two weeks after picking, except at a prohibitive cost.

This powerfully deterring factor kept it out of the commercial market until the advent of the fast train, the steamship, and the refrigerator car. It is now marketed all over North America and even shipped across the ocean. If the fruit is to arrive at its destination in perfect condition it must be picked at a certain time. One day before or one day after this time will not do. This means that a large peach orchard must be carefully planted, so as to have a perfect succession of varieties, in order that the peach pickers may be fully employed during the ripening season. This method of planting is also necessary to avoid glutting the market and so incurring ruinous losses.

The peach tree blossoms early and the flower buds break before the leaves come. This tendency to early flowering limits the cultivation of peaches to those regions which are not subject to early spring frosts. It also requires a warm summer and a large amount of sunshine for proper ripening. These exacting requirements prevent peaches from being commercially cultivated in Great Britain, the north of France, Germany, Holland and Belgium.

The peach belts of North America are:

(1) Southern Ontario.

(2) Western New York State.

(3) Along the so-called Finger Lakes of New York State.

These three areas are able to produce a peach crop because of the proximity to the Great Lakes. The great area of cold water surface makes the spring temperatures so cool that the blossoming of the trees is delayed until the disappearance of the spring frosts.

(4) A belt about ten miles wide along the eastern shore of Lake Michigan.

This is also made a peach belt by the influence of the Great Lakes. It is made so by the prevailing west winds, blowing from the lake on to the land, producing the necessary retardation of the blossoming.

(5) The Peninsula east of the Chesapeake Bay in Delaware and Maryland.

This is largely the result of the frost-protective action of a great body of water.

(6) The Alleghany Peach Belt.

Here the cooler climate of a mountain region delays the blooming of the trees, and also the factor of frost drainage enters. Cool air is heavier than warm air, so on frosty nights the cold air settles to the lowlands leaving the higher land frost-free. This is geographically known as frost drainage. It is seen also in the Ozark Plateau.

(7) The Hills of Southern New England.

Peaches are found to do better upon hill tops than upon lowlands. The hill tops overlooking the Connecticut Valley in the State of Connecticut are now covered with prosperous peach orchards.

(8) The Ozark Peach District.

This is a fine peach district and its suitability is due to the frost drainage already mentioned.

(9) The Southern Peach Districts.

These are largely in Central Georgia. The district owes its importance to the fact that the peach ripens several weeks earlier in this region than in the northern

areas. The express service enables them to gain the advantage of the high prices of an early market. The crop is, however, very uncertain.

(10) California.

The main area is around Fresno. It is the most certain of all the peach belts of North America, but frost destruction is not unknown.

European peach belts are located in Spain, Portugal and Southern France. Northern Africa has an important peach-growing area. Most of the peaches consumed in Great Britain, Northern France, Germany, Belgium, and the Netherlands come from these European and African belts.

In the Southern Hemisphere, Chile, Argentina, South Africa, Australia and New Zealand all produce excellent peaches. South Africa is the only one of these countries which exports them. The fast mail steamers of the Union-Castle line carry fair quantities of the fruit to Southampton in February and March. They fetch high prices on the early London market. The supply is, however, limited, since the Boer farmers are very conservative in their methods and convert most of their crop, which is of low quality, into peach brandy. Cecil Rhodes spent large sums from his private income in demonstrating to them the value of their peaches, but his efforts met with little response from them. The Boer is by preference a stock-raiser rather than a fruit-farmer.

103. Canning of Fruit and Vegetables. Vegetable canning has already been dealt with. What was said about it applies in large measure to the canning of fruit. Canned fruit and vegetables are important imports into Great Britain. Canada and the United States are perhaps the most favorably situated nations to capture this market.

Fruit is often turned into jams, jellies and marmalades instead of being canned. The preserve industry is important and should be capable of great extension in Canadian fruit-growing regions.

Canned pineapples from Hawaii and the Straits Settlements are important canned fruit imports into Britain, Canada and the United States. Many of the luscious fruits of the tropics are incapable of transportation in the raw state, but they offer a field for the further extension of the canning industry.

104. Dried Fruits. The principal dried fruits entering into world commerce are prunes, raisins, figs, dates, currants, apricots, etc. In the days before the development of rapid transport almost the only means of fruit preservation were such expensive ones as preserving them in sugar or brandy or pickling them with vinegar. Today rapid transport has worked a great change by developing a large traffic in dried fruits from regions having unusually favorable conditions for their production. The ease with which fruit can be dried in countries having the Mediterranean type of climate has resulted in a large trade in

dried fruits from these lands. Raisins and currants are carried from Asia Minor, Greece, Italy and Spain in Europe; and from Chile, Argentina and California in the Americas. Dried figs are shipped from Northern Africa, the European Mediterranean countries and California. The nourishing date is gathered in the desert oases of the Sahara and Asia Minor and shipped in a dried condition to all parts of the globe. The prune, which is simply a dried variety of plum, is sent to us from California, Chile and the Mediterranean countries. France and Italy are the leading exporters of prunes in the world. Smyrna is the leading centre in the world for the exportation of Sultana raisins.

Malaga in Spain leads in the exportation of the large raisins so popular for Thanksgiving and Christmas festivities.

The apricot is a near relative of the peach. The disadvantages attendant upon peach production are also the difficulties of the apricot-grower but in a much greater degree. It is seldom exported in the fresh condition. Immense quantities, however, enter the world trade in the dried form. It is grown extensively in Northern India and in the oases of Bokhara and Samarkand. The Northern India apricots are dried and transported by caravans over the snowy and dangerous passes of the Himalayas into Tibet and Western China, where they are greatly prized. The Central Asian product reached the world markets, prior to the disruption of Russia, by rail to Krasnovodsk on the Caspian. Here steamers took the product to Baku, Derbend or Petrovosk. From these places it was shipped by rail to Novorossiysk, where ocean liners carried it to the European markets. Smyrna is the leading exporter of figs. In Australia the irrigation district of Mildura is sending large quantities of dried fruits into the world's markets, dried prunes, peaches, apricots, currants and raisins being Mildura's principal contributions. South Africa is also entering the dried fruit industry, but her exports are as yet small. Chile and Argentina both have important dried fruit industries, but they export very little, their whole output being absorbed by their own cities.

105. The Citrus Fruits. The commercial citrus fruits comprise the orange, lemon, grapefruit, and the lime. They were probably first cultivated in South-Eastern Asia. None of them can be cultivated in regions of severe frosts. The orange is more frost-resistant than any others, but the powers of even the orange in this respect are but slight.

Citrus fruits grow on many varieties of soils, but the chief requirement is a soil texture which will permit of free underdrainage. This quality is found at the foot of the mountain regions in those lands possessing the Mediterranean type of climate.

In the United States, Florida and California are the chief producing centres and they provide practically all the citrus fruits marketed in Canada and the United States. In recent

years the West Indian Islands have sent increasing quantities to Eastern Canada.

In Europe the chief producing region is Valencia in Spain. This small district produces almost as many oranges and lemons as do California and Florida combined.

About one-half of the Spanish crop is sent to Britain. Germany, France, the Netherlands and Belgium are also important buyers of Spanish citrus fruits.

In Italy the citrus fruits are grown in three regions, viz.: On the Gulf of Genoa; the region around Palermo in the island of Sicily; and the Neapolitan region. The Palermo region is the most important, whilst the Genoese location is unimportant commercially, but interesting because of its high latitude for orange culture. The French colony of Algeria is an important source of oranges to the French.

106. Other tropical fruits are the banana (already discussed), the fig, date, and olive.

The fig and olive cannot be transported far as fresh fruit and are usually classed with the dried and preserved fruits, in which form they are generally exported.

The olive, more than any other fruit crop, is adapted to those regions having the Mediterranean type of climate. The distribution of the olive is determined by its inability to withstand frost, together with its power of thriving in arid regions. It is thus splendidly adapted to the dry slopes of the Andalusian Mountains in Spain, the Apennine slopes of Italy and the mountain slopes of Greece. The olive is the universal crop of all the Mediterranean countries.

The olive is principally grown for its oil, although large quantities are preserved in brine or by cold pack methods and shipped abroad for table use.

Most of the olive oil of the Mediterranean lands finds it way to Marseilles, the great vegetable oil centre of the world. Here it is mostly converted into soap. The world-famous Castile soap is produced from olive oil.

107. Grapes and the Manufacture of Wine. The grape is important as a food material and for the manufacture of wine. The chief climatic requisite of the grape is a summer of considerable heat, which must last well into the month of September in northern latitudes.

It is essentially a plant of the semi-arid regions. Its roots are deeply penetrating. This enables it to reach down to the permanent soil water of the semi-arid regions and makes it fairly independent of rains. Too much moisture is detrimental to grape culture. Accordingly we find the grape at home on the northern and southern edges of the sub-tropical belts in each hemisphere. The plant is very subject to fungus diseases induced by combined heat and moisture. One of these, called "Oidium," has practically wiped out the vineyards of the Ma-

deira Islands. It is also dreadfully ravaged by an insect pest known as "Phylloxera." This insect attacks both the roots and leaves of the grape vine and has wrought great havoc in the vineyards of France, Spain, California, South Africa, Australia and North America. The geographical range of the grape is limited by its climatic requirements of a long, warm and comparatively dry summer. It is therefore, specially adapted to lands having the Mediterranean type of climate.

In Europe the principal vineyards lie south of a curved line drawn from the mouth of the River Loire in France to latitude 53 degrees north in East Germany. From here the line drops abruptly to the Adriatic Sea and crosses the Balkan Peninsula, reaching the Black Sea near Galatz, reappearing again in Russia around the Sea of Azov. From here it goes eastward through Russia and Asia approximating with latitude 45 degrees north. In North America the northern line of the grape limit curves from 37 degrees north in California to 44 degrees north in Ontario, this northward thrust into Canada being due to the climatic influence of the Great Lakes already discussed with reference to peaches.

In the Southern Hemisphere the grape is grown in all of the settled regions having Mediterranean climates, viz.: South Africa around the Cape of Good Hope, the south-western and south-eastern tips of Australia, and in the temperate zone of South America.

108. The Wine Industry. As a national industry wine-making attains its greatest importance in France, Italy, Spain and Portugal, these countries producing about five-sixths of the world's wine. Austria, Russia, Switzerland and the United States are also important wine-makers and grape-growers.

The four European nations referred to, however, have long held their supremacy in grape culture and wine-making in spite of the great efforts to establish these industries elsewhere. The reasons for this long-held supremacy appear to be:

(1) It is an intensive industry.
(2) It requires a dense population, since much labor is necessary to produce the grapes.
(3) Expensive appliances are required for the fermentation, and great skill is necessary to obtain the desired flavors in the final product.
(4) Local conditions of soil and climate seem to give certain flavors to the grapes, e.g., Burgundy with its high iron content.
(5) The variety of wine is named after the name of the place producing it, e.g., Burgundy, Madeira, Port (Oporto), Champagne, Moselle, etc. This naturally focuses the attention of buyers to these places when laying in their stocks.

All of these factors, it will readily be seen, operate strongly against new lands competing in the wine industry against these long-established producers.

French Wine Industry—

France produces more wine than any other country. The more important wine regions of France are: The Loire Valley, the Bordeaux region, Burgundy (chiefly in the Saone Valley), and the Midi. Notwithstanding the fact that France is the leading wine producer of the world, it is somewhat surprising to find that the French import more wine than they export.

Only the higher class French wines like Champagne, Burgundy, Medoc, etc., are exported. The inferior wines are consumed locally and are supplemented by large imports of similar wines from Italy, Germany and Spain. The total quantity of wine consumed in France is incredible. It has been estimated that one billion gallons per year is about the average.

Italian Wine Industry—

Italy depends more on her grape-growing and wine industries than does any other nation. She exports large quantities of wine and about one-sixth of all the cultivated land of the country is devoted to grape-growing.

The Spanish Grape and Wine Industry—

Spain, besides being the third greatest wine-producer in the world, is also a great exporter of fresh grapes. These are principally exported from Malaga and the south-eastern ports. The annual value of fresh grapes shipped in boxes from Spain to Great Britain alone is well over three million dollars. Sherry is the best known Spanish wine.

The Portuguese Wine Industry—

Portuguese conditions are similar to the Spanish. Wine-making is very important to Portugal. About one-tenth of the cultivated land is in vineyards and wine makes up about a half or more of the exports of the land. Port wine is the leading wine shipped from Portugal. The principal users are Great Britain and Brazil.

Australian Wine Industry—

The vine is easily cultivated in Australia. Victoria is said to produce wine as good as any in the world. The industry is small, largely owing to sparsity of population. The exports are very small, since the reputation of Australian wines has yet to be established.

South Africa—

The Afrikanders claim to have the right conditions of soil, sunshine and moisture in the western part of Cape Colony to make it the best grape-growing region of the world. Certainly it is true that for lusciousness and size the "Cape Hannepot" is not excelled by any other grape in the world. These are exported in considerable amounts to Great Britain, where they arrive in the spring and command the high prices of an early market before the Spanish grapes arrive.

The Afrikanders are able to do this owing to the reversal of the seasons in the Southern Hemisphere. The introduction of fast steamer connections and cooling chambers on boats is rapidly enabling the industrial populations of the north temperate lands to become almost independent of seasonal variation in food supply.

North America—

The North American grape industry is centred around two main regions, which are widely separated, viz.:

The Great Lakes region or Eastern region.

California or Western region.

The grapes are grown for wine, for table use and for raisins. The San Joaquin Valley of California supplies nearly all the raisins used in Canada and the United States. In Southern Ontario, New York State, and Michigan, large quantities of grapes are grown for table use and also for conversion into grape juice and wine.

South America—

The South American grape industry centres round the longitudinal Valley of Chile, south of Valdivia, and around the irrigated land of Mendoza in the Argentine Republic. Wine is made in both regions and is all consumed locally.

By-Products—

The most important by-product from the wine-making industry is cream of tartar. This is obtained by refining the dried lees of the wine, or sediment obtained in clarifying. In the crude form this sediment is called "Argols," and is used as a reducing agent in metallurgical operations.

109. Sugar and Sugar Refining. The sugar supply of the world is obtained principally from sugar cane and sugar beets, about half the world's supply coming from each. Other sugar-producing plants of minor importance are the maple tree, the date palm, sorghum and maize. The general use of sugar as a food is of comparatively recent origin. It was first used in Europe as a drug and in 1589 a pound of sugar was as expensive as a whole quarter of veal. By 1700 the total consumption of sugar in all European countries was only 50,000 tons per annum. This quantity would today scarcely supply the Canadian requirements for more than a few weeks. It will be seen, therefore, that sugar must form an important article of commerce between nations.

Sugar is a plantation crop and is the most important plantation crop in the world. It is estimated to reach a value of one and a half billion dollars yearly.

Beet Sugar—

The production of beet sugar on a commercial scale only dates back to the early years of the nineteenth century. The

discovery of the sugar possibilities of the beet is credited to the German chemist Margraff, who, in the latter half of the eighteenth century, called attention to the fact that sugar could be extracted from beets. No use was made of his discovery until the blockade of continental Europe by the British navy during the Napoleonic wars cut off the continental nations from their cane sugar supplies. The nations thus deprived of cane sugar looked around for another source of supply. Many sources were investigated but none were found satisfactory. One of Margraff's pupils remembered his master's paper on "Sugar from Beets," and drew the attention of the scientists to it. From the investigations thus started, the beet industry of today has developed. It was first established in France by a decree of Napoleon I, issued on January 15, 1811. The careful and painstaking chemical genius of the German people has resulted in placing Germany at the head of the nations producing beet sugar. Beets are rapidly becoming an important source of sugar in the United States and efforts are being made to grow them in Canada. The culture of the sugar beet is being attempted again in Southern Alberta, although former attempts along this line were not entirely successful.

Comparison of Beet and Cane Sugar—

Considerable discussion is continually being raised (usually by people who know little of the subject) as to the relative merits of these two sugars.

Scientists claim that chemically they are identical substances and therefore they must have the same properties. Yet people often say that beet sugar is not so sweet as cane sugar, and that it cannot be used successfully for canning, jelly-making and preserving. With a view to settling this vexed question, Professor G. W. Shaw, of the California Experiment Station, carried out a series of experiments.

The conclusion from these experiments was that the sugar derived from both sources was equally good, and gave equally satisfactory results, both for household and commercial uses. Any differences occurring, like degrees of fineness in granulation, seemed to be due to processes of manufacture rather than to difference in the composition of the sugars.

Climatic Requirements of the Beet—

Large-scale production of the beet entails rather exacting climatic and soil conditions. Climatic requirements are a moderate amount of spring and summer rain, moderate summer heat, and a cool, dry fall. Irrigation is suitable for beet production when the soil is favorable.

Soil Requirements—

Fertile, mellow soil, rich in lime and neither too clayey or sandy, gives the best results. It must be finely prepared and deeply ploughed. The ploughing must be so deep that a subsoil plough must follow the ordinary plough.

Care of the Plant During Growth—

The young plant is so small that mechanical cultivation is impossible in the early stage of growth, during which period it must be kept clear of the weeds which soon would choke it out. This means that early weeding must be done by hand. After a while, when the plants have become established, they must be thinned out with the hoe. Up to the present no satisfactory machine has been invented to replace this hand labor.

Harvesting—

The beets are ploughed out of the ground in the late fall and the tops pulled off by hand. The roots are piled, covered with straw or earth, and delivered to the factory during the winter months.

This great dependence on hand labor greatly deters the cultivation of the beet for sugar production in new lands, since a ready supply of cheap labor is not usually available in sparsely populated regions.

Outline of the process of the production of raw beet sugar:

Beets are grown, harvested, topped, washed, sliced and diffused, yielding pulp and crude juice. The crude juice is screened, defecated and filtered, yielding juice and albuminous matter. This product is concentrated in a vacuum and centrifuged, yielding molasses and raw sugar.

The raw sugar is then sent to refineries.

The By-Products of the Beet Sugar Industry are very important, since they play a great part in enabling beet sugar to be produced cheaply enough to compete with cane sugar.

The by-products of the field are leaves and tops, which are fed to cattle, and give a return of from $4.50 to $5.75 per acre.

The factory by-product is the pulp from which the sugar has been extracted. This is taken back by the farmers growing the beet and fed to cattle. It averages, in Germany, $10.40 per acre.

It will thus be seen that large scale beet production plays an important part in cattle-keeping on the small farms of Northern Europe.

European centres of production are: Central Germany near Magdeburg, Holland, Belgium, and the north of France.

North American centres are: Eddy County, New Mexico; Bay County, Michigan; Vendura County, California; and Spokane County, Washington. But many other states are also producers.

The Sugar Cane—

The sugar cane belongs to the family of grasses. It can be grown in a variety of climates, but is best grown where the

climate is moist and warm, with intervals of hot, dry weather. These conditions are found near the coast in tropical and sub-tropical regions. The sugar cane is not grown extensively outside the tropical or sub-tropical belts.

Sugar cane does not require hand cultivation like the beet. It is cultivated with ploughs. Some of the very large plantations use steam ploughs.

Sugar cane is adapted to all moist lowlands lying between Louisiana and Argentina in the Western Hemisphere, and between Southern Italy and India, Natal and Queensland in the Eastern Hemisphere. India is the greatest sugar-producing country in the world, but its vast population absorbs all it produces and requires in addition an ever-increasing supply of sugar from the outside. The main concentration of sugar cultivation is in the valley of the Ganges.

Cuba is the second largest world's producer and is the largest exporter of cane sugar. Java ranks after Cuba and India, Hawaii, Brazil, Mauritius, Queensland and Louisiana and the West Indies, including the Guianas, are other very important cane sugar producers.

Outline of the production of raw cane sugar:

Cane cut in the green stage.
Cane crushed, yielding begasse and crude juice.
Crude juice screened, yielding woody fibre and juice.
Juice treated with milk of lime and residue removed.
Juice concentrated.

(*a*) Boiled down in open kettles.
Drained into casks (molasses—Muscovado).

(*b*) Boiled down in vacuum.
Separated in centrifuge, giving molasses and raw sugar.

World's Sugar Production Statistics—

CHIEF PRODUCERS OF CANE SUGAR:

Source—	Thousands of Tons			3-Year Average
	1920	1921	1922	
Cuba	3,936	3,996	4,000	3,977
Java	1,508	1,650	1,750	1,636
United States	1,106	1,150	1,050	1,102
Peru	344	320	340	334
Brazil	340	492	425	419
Japan and Tai-wan	342	407	406	385
Mauritius	260	182	225	222
Argentina	202	172	200	191
San Domingo	185	225	200	203
Philippines	182	299	300	260
Natal	155	147	141	147
British West Indies	143	166	165	158
Mexico	115	120	120	118
Demerara	96	108	100	101
British India	2,506	2,500	2,575	2,527

NOTE.—The British India crop is all consumed locally and does not enter into foreign trade. It is, therefore, shown last in the above table.

CHIEF PRODUCERS OF BEET SUGAR:

Source—	Thousands of Tons 1920	1921	1922	3-Year Average
Germany	1,153	1,306	1,550	1,336
United States	970	911	625	835
Czecho-Slovakia	706	660	750	705
Holland	317	376	285	326
France	305	278	560	381
Belgium	243	290	295	276
Poland	190	225	270	228
Spain	171	135	170	158
Sweden	164	231	72	155
Italy	135	217	260	204
Denmark	134	147	105	128
Russia, including Ukrainia	88	49	220	119

The Canadian production during the same period was:

1920—35 thousand tons.
1921—20 thousand tons.
1922—15 thousand tons.

The chief consumers of all the sugar exported are:

The United States	about	30%
Great Britain and Ireland	"	25%
British India	"	10%
China	"	5%
Canada	"	4½%
Rest of the world	"	25½%

113. Refining of Sugar. Very little sugar is sold direct to the consumer in the raw state. This is due to the demand of the public for a pure white sugar. In the case of beet sugar refining is absolutely necessary because the raw beet sugar has a disagreeable odor and taste. Cane sugar, however, is more fragrant, and its taste more agreeable in the raw state than in the refined condition.

Refining is a process which requires great care and attention to details. It can only be done economically in large establishments. These are usually located on a navigable river, where cargoes can be readily received and unloaded. An abundant supply of good water is a necessity.

The process consists, essentially, in dissolving the crude materials, separating the impurities, and recrystallizing the sugar.

Outline of the Refining Process—

Raw sugar washed.
Centrifuged, yielding wash syrup and washed raw sugar.
Washed raw sugar melted.
Defecated.
Filtered through bags.
Liquor is bone-blacked.
Boiled down in vacuum.

Centrifuged { Syrup. / Sugar. } { Syrup. / Yellow sugar.

In 1922 Canada had seven sugar refineries operating. Their total gross production of refined sugar and syrups was valued at $70,822,782.

The great solubility of sugar when refined, renders it liable to great losses during transportation overseas. Hence it is usually refined near the centres of consumption. The refineries are usually situated at ports. The principal Canadian sugar refineries are situated in Montreal, St. John, Vancouver and Wallaceburg, Ontario.

114. By-Products of Sugar-making. It must be remembered that there are two distinct methods of refining sugar, viz.:

(1) The crude and primitive methods still used for refining local supplies in such countries as Guatemala, Venezuela, Porto Rico, Jamaica, etc.

(2) The highly organized large-scale modern method by which practically all commercial sugar is produced.

We, therefore, find the by-products differing in each case.

The principal by-product from the primitive refineries is molasses, which contains a high sugar content. This high sugar molasses forms a staple food in tropical America. It is also distilled and the spirit known as rum is obtained. Rum and good tasty molasses, then, are only by-products of sugar in those regions where primitive refining methods are still used. The heavy pressures and hot washings given in modern refining removes 95% of the juice. Therefore the molasses from the modern refineries is almost tasteless. It is only fit for the production of industrial alcohol and the preparation of cattle foods.

Consequently the by-products of the modern mill are industrial alcohol in place of rum, and various forms of cattle food like Molassine meal, Molassquite, etc., which take the place of the old-fashioned molasses and treacle of a generation back.

The crushed cane is called "Begasse." It is used as a fuel to provide the power to run the mill and heat the water required in the extractive and refining processes.

115. The Manufacture of Glucose or Corn Syrup. This should properly be taken up along with the study of corn or potatoes, since most of the glucose or corn syrup on the market today is obtained by treating potato or corn starch with either sulphuric or hydrochloric acid. Some of it, however, is obtained from Sorghum canes. Glucose is produced naturally in the juice of many plants, e.g., grapes, cherries and sweet corn. The main commercial source is, however, starch. This is due to the cheapness of that material. Starch is a very complex carbohydrate which, by a process called hydrolysis, splits up into simple forms of carbohydrates, the most important of which is glucose.

If common starch be carefully stirred with a little concentrated sulphuric acid, it will be seen to change gradually into a sticky, gelatinous compound. This is glucose.

Glucose or corn syrup is sold both in the liquid and solid forms. It is also sold white or colored and with or without flavoring. The usual commercial forms contain about 50% glucose. If much more than 50% glucose be present it becomes a solid which is known as corn sugar.

Uses of liquid glucose or corn syrup:

For confectionery, syrups, jams, jellies, pie filling, puddings, preserves and mince-meat.

It is also used in brewing beer; in the manufacture of chewing tobacco; in silvering mirrors; in liquid soaps; in hair tonics; in shoe-blacking; in food sauces; in canning meats; in making pastes and sizes for painters, and textile manufacturers and textile printing; in tanning leather; and also in polishing rice.

Corn syrup is used in brewing; in making caramel; in vinegar-making; and in bread-making.

Process of Manufacture—

In Europe glucose is usually made from potato starch and in America from corn starch.

In either case the manufacturer must use the process of hydrolysis. The European manufacturers use sulphuric acid and the Americans use hydrochloric acid as the hydrolizing agent.

The European manufacturer neutralizes the excess acid left over by adding marble dust. This forms calcium sulphate, which will not dissolve in water. During the refining process this insoluble substance is removed. The American manufacturer prefers hydrochloric acid and neutralizes with soda ash. The product of neutralization is, therefore, common salt, this being harmless if it is not removed from the glucose during the refining process. American glucose, therefore, always contains common salt. After hydrolysis by either method the glucose solution is filtered to remove small amounts of fat and protein occurring in the starch. It is decolorized by bone-blacking and then evaporated to the desired degree of concentration. If corn sugar or solid glucose is required, concentration must be carried on until the liquid contains not less than 86% glucose. It is then either crystallized or allowed to harden in pans.

In Canada, Ontario produces considerable amounts of glucose or corn syrup. The greater portion of the glucose used on this continent is, however, produced in the corn belt region of the United States.

116. The Maple Syrup Industry. This industry is confined to Eastern North America. Maple sugar is really the same sugar as cane or beet sugar, but owes its peculiar flavor and aroma to the presence of certain impurities. It is these impurities which give it its value in commerce. They are, therefore, not refined out.

Maple sugar is especially valued as a confectionery material and as a foodstuff. It is not well known outside America, since the limited amount produced does not provide a surplus for export.

Its process of manufacture is simple and can be easily carried out by small farmers. When America was discovered the Indians had already discovered how to produce it from the sap of the maples which are so abundant in Eastern America. They taught their crude methods to the European settlers. It is thus one of our oldest industries.

During the past 50 years, however, the industry has become commercialized and is now quite highly organized.

Details of the modern method of manufacture and much interesting material regarding the industry can be obtained by writing to the Department of Agriculture, Ottawa, for the pamphlet *The Maple Sugar Industry of Canada,* by J. B. Spencer, B.S.A., published in 1923.

Quebec is the principal producer, followed by Ontario, New Brunswick and Nova Scotia. The total value of the sugar and syrup for 1924 is placed by the Dominion Bureau of Statistics as $5,991,441. This was distributed among the Canadian producers as under:

	Maple Sugar	Maple Syrup	Total
Quebec	$1,775,305	$2,235,646	$4,010,951
Ontario	97,747	1,795,276	1,893,023
New Brunswick	17,037	27,368	44,405
Nova Scotia	17,510	25,252	42,762

In the United States the industry is particularly important in White Mountain region of Vermont and New Hampshire.

The maple sugar production of the United States for 1920 was estimated to be over 36 million pounds. This was obtained by tapping more than 19 million trees.—(Estimate of the United States Department of Agriculture.)

117. Cotton and Universal Use of Cotton.

Of all the vegetable fibres used by man, there is none which approaches cotton in its value to the human race. Its use is universal and it is employed not only for the manufacture of textiles, but for scores of other purposes, from kodak films to high explosives.

Its value to man rests upon:

(1) Its cheapness.
(2) Its availability.
(3) The amount and variety of its uses.
(4) Its suitability for clothing.
(5) The various forms in which it may be manufactured as a textile.

All nations nowadays use manufactured cotton in some form or other as articles of clothing.

It is used by civilized nations and by the dwellers in the most backward regions.

It is fashioned into the finest threads, laces and fabrics. It is also used for heavy blankets, sailcloth and as a packing material. It may be specially treated to make it resemble silk, linen and wool. Recently it has been treated chemically so as to produce a material which only the expert can distinguish from real silk. It enters into the manufacture of automobile tires. Toilet articles are made from it. Cotton is a necessary constituent of billiard and pool balls. The sportsman and the soldier require it for their ammunition. The engineer uses it in blasting roads and tunnels for transportation, and in his efforts to extract the metals from the rocks. The stock feeder makes use of it to fatten his animals. The maker of floor coverings demands it. In short, there is hardly an industry which does not require cotton in some form or other.

118. Climatic and Soil Requirements of the Plant. The plant is seen in many forms, some of which are annuals, others biennials, and some are perennials.

Some cotton-bearing plants are low shrubs and others are trees. They all belong to the mallow family, which also gives us the hollyhock and the marshmallow. Cotton is of tropical origin, but it is now grown in many places between 40 degrees north latitude and 30 degrees south latitude.

More than half the cotton is cultivated in temperate latitudes. It thrives best in a warm, humid atmosphere, with ample rainfall, and a light loamy or sandy soil, which keeps damp and yet holds the heat.

It develops the highest quality of fibre when grown in a moist, even climate, with warm summers, and with salt in the air and the soil. It is, therefore, well adapted to delta lands. Rain in spring is necessary for the development of the root, stem and leaf; but heavy summer rains when it is maturing injures the production of the bolls. It will grow under irrigation but natural humidity is better for it. The plant is very sensitive to frost; it grows rather slowly so that it requires at least six months free from frost. Again, the nights must be warm as well as the days. The ideal rainfall is of the summer thunderstorm type with periods of bright, warm weather between rains. As the cotton matures and the bolls open, frequent rains are liable to damage and discolor the cotton.

Cotton may be successfully planted and cultivated by machinery, but the picking must be done by hand. This necessitates a plentiful supply of cheap labor during the picking season.

119. The Application of Mechanical Power and Devices to the Textile Industry.

The greatest factor in economic use of cotton is, however, the application of machinery to its transformation from fibre to cloth. The whole story of cotton is bound up with a series of brilliant mechanical inventions. The principal ones are:

John Wyatt's invention of the drawing roller. This enabled threads to be spun without using the finger; date 1738.

Lewis Paul invented the carding cylinder in conjunction with Wyatt in 1748.

John Kay invented the fly shuttle, 1738.

Robert Kay, son of John, invented the drop box, 1760.

Hargreaves invented the spinning jenny, 1764-1767.

Arkwright invented the water frame, 1768.

Crompton invented the mule frame (which combined Arkwright's and Hargreaves' ideas), in 1790.

Leigh invented the apron feed in 1772.

Cartwright invented the power loom, 1789.

Cartwright applied Watts' steam engine to Arkwright's spinning frame in 1790.

Eli Whitney invented the cotton gin, 1794.

Roberts invented the self-acting mule, 1830.

The most epoch-making discovery in the cotton industry was undoubtedly Eli Whitney's invention of the cotton gin. This invention enables the seeds to be removed from the fibres quickly by machinery, instead of slowly and painfully by the method of hand-picking. Since that date cotton has steadily increased in importance until today it leads all other vegetable fibres.

These inventions produced what is known as the industrial revolution. For further information and summary of its results consult Mowat's *History of Great Britain,* Chapter XXIV, pages 510 and 511 and pages 539 to 541.

120. Important Cotton-Growing Areas. The leading cotton-producing countries are the United States, Egypt, India, South America, Russia and China.

The United States areas are:

(1) The coast and coastal islands of South Carolina, Southern Georgia and Northern Florida.

(2) The Uplands of the Southern Atlantic States.

(3) The coastal region of the Gulf of Mexico.

(4) The Mississippi Valley States.

The first region produces Sea Island cotton, the finest cotton in the world. The second region gives us American Upland cotton. The cotton from the third region is Gulf cotton. The Mississippi Valley gives us the "Peeler" cotton.

The West Indies also produces considerable cotton, a very beautiful variety growing in the Barbadoes. This sells for 50 cents a pound and is purchased outright every year by J. and P. Coats, the great thread-makers.

Egyptian cotton is mainly grown on the delta lands of the Nile and produces a splendid variety of cotton which is naturally brown in color. Egyptian white cotton is grown on the irrigated lands farther up the river. British Sudan is being rapidly developed into an irrigated cotton district.

India is the world's second largest producer of cotton. The crop is distributed over three general regions—

(1) The Indo-Gangetic Plain.
(2) The Central Western Zone extending from Rajputana to the Deccan.
(3) The Deccan.

The highest grade Indian cotton is grown in Southern Madras, near Tinnevelly, Madina and Coimbatore.

The most important cotton-producing region of India lies along the Nerbudda and Tapti rivers, and extends across Bombay, Baroda and Berar. In the Punjab and Lower Indus Valley cotton is grown under irrigation.

Indian cotton is almost all raised on small holdings and by hand cultivation. In these respects the Indian methods of production are just the opposite of the American methods.

China produces about four million bales per annum, of which about one and three-quarter millions enter the world's commerce. The main cotton-growing regions are the valleys of the Hwang Ho and the Yangtse Kiang. Cotton is an especially important crop along the Grand Canal, which connects these rivers.

Yunnan Province is an important producer, and small amounts are grown in Manchuria and Chosen. Japan also grows a little cotton. Russian cotton comes from Turkestan chiefly, although some is also grown in Transcaucasia.

Brazil was in former times a large cotton producer. Climate conditions are, however, not very favorable, and cotton no longer bulks very large in the exports of Brazil.

Peru is a small producer, but the crop is very important because it forms a very special grade. Peruvian cotton is crinkly and brownish in color. This crinkly feature is of considerable importance because it makes it possible to mix the cotton with wool for making expensive fabrics.

121. Cotton Ports of the World.

North America—New Orleans, Galveston, Memphis, Norfolk, Charleston, Washington, Savannah, Mobile, and Pensacola.

South America—Pernambuco, Rio Janeiro, Callao.

Africa—Cairo, Alexandria, Port Sudan.

Asia—Bombay, Madras, Hong Kong, Shanghai.

WORLD'S COTTON CROP

Producer—	Millions of Bales 1921	1922	1923	3-Year Average
United States	13.7	8.4	10.2	10.76
India	3.6	4.5	5.0	4.36
Egypt and Sudan	1.2	0.9	1.1	1.06
Russia	0.15	0.15	0.15	0.15
China	1.5	1.5	1.5	1.50
Others	1.6	1.5	1.6	1.56

Indian bales weigh 400 lbs. each.
All others 500 lbs.

CHIEF CONSUMERS OF COTTON

Country—	Millions of Bales 1921	1922	1923	3-Year Average
Great Britain	3.50	2.000	2.90	2.800
Germany	0.08	0.047	0.06	0.062
France	0.50	0.900	1.20	0.866
Russia	.....	0.900	0.60	0.500
Poland	0.07	0.200	0.25	0.173
Austria	0.0	0.090	0.10	0.063
Czecho-Slovakia	0.09	0.300	0.40	0.263
Italy	0.70	0.800	0.80	0.766
Spain	0.40	0.300	0.40	0.366
Belgium	0.20	0.200	0.20	0.200
Switzerland	0.50	0.300	0.30	0.366

The above are non-producing nations.

Cotton Manufacturing Statistics—

SPINNING, 1922.

	Number of Spindles
Great Britain	56,605,176
United States	36,943,000
France	9,600,000
Germany	9,500,000
Russia	7,100,000
India	6,870,804
Japan	4,645,853
Italy	4,560,000
Czecho-Slovakia	3,549,845
China	2,247,936

Cotton-weaving—

The average over the last 25 years shows the following percentage of production of finished cotton goods for the world:

Continental Europe	33%
U. S. A.	27%
Great Britain and Ireland	23%
India	9%
Rest of the World	8%

Notice that European factories account for 56% of the production.

The United States is rapidly becoming a manufacturer of finished cottons. The climatic conditions there, as well as the type of labor supply, forces the U.S. into the manufacture of the cheaper and coarser cotton stuffs, such as canvas, etc. The finest cotton materials still come from Lancashire. The production figures given above include such commodities as sewing cotton, cotton knitting, yarns, stockings, etc.

122. The Principal Cotton Manufacturing Regions of the World Are:

In Europe—

British Isles—Lancashire, Scottish Lowlands, Nottinghamshire, Belfast, are the principal centres.

France, Germany, Poland, Czecho-Slovakia and Spain.

In the United States—

Massachusetts, Rhode Island and Pennsylvania in the north; South Carolina, North Carolina and Georgia in the south.

In Canada—

Cotton is woven in Quebec and Ontario and forms the chief branch of the textile industry in those provinces. In 1922 there were 33 mills in Canada engaged in working up cotton yarn and cloth. The gross value of their products was over 72 million dollars.

In Asia—

Cotton-weaving is an important industry around Bombay and Madras in India, and in the Shanghai area in China. Here are to be found many modern factories.

Japan is also an important manufacturer of cotton goods, these forming about 20% of her total exports. Japan imports all the raw cotton for her manufactures.

123. Insect Pests. There are several kinds of pests which act injuriously on the cotton plant. None are more dreaded than the insect pests. They are found in all cotton-growing regions and the annual loss through their ravages is colossal.

The insect pests attack different parts of the plant during various stages of its growth, but the most dreaded are those which attack the boll.

Of the chief forms of insect pests, three especially stand out into prominence. Two of these belong to the moth tribe of insects. The third is a beetle.

The Cotton Caterpillar is the caterpillar of a moth. This moth flies by night. The female will lay from 600 to 1,000 eggs. Several generations are produced in a season. The caterpillar eats the young leaves, often completely denuding the whole plant.

The Boll Worm is the insect which is commonly known in the corn belt as the Corn Ear Worm. The adult moth is said to lay a thousand eggs at one time. The caterpillar attacks the bolls and ruins the cotton. Spraying is the usual method of control adopted. This, of course, adds greatly to the expense of raising cotton.

The Boll Weevil—

This fearful pest appears to have crossed into the United States cotton fields from Mexico. It was first noticed in Texas in 1892. Since that time it has rapidly spread northward and it is feared that it will completely envelop the whole cotton area of the United States by 1930.

So far it has absolutely defied all efforts of man to control it. Its control is one of the greatest economic problems facing American cotton planters today.

The adult beetle is reddish brown in color and about one-quarter of an inch long. The eggs are laid in the young bolls, and hatch quickly. The young weevil eats its way quickly into the boll, destroying much fibre. The insects multiply rapidly, four to five generations being produced in a season. It is said that one female may have as many as 250,000 descendants in one season. It has been estimated that in some years the damage done to American crops alone by these three pests is in the neighborhood of twenty million dollars.

124. By-Products of Cotton. During the last fifty years cotton by-products have assumed a large place in the industrial world. The principal are:

Linters—This is the down left upon the seeds after the ginning process. It is then removed and made into poorer grades of cotton cloth. After being chemically treated it is also used in artificial silk manufacture.

Seeds—These are pressed and a valuable oil, called cotton seed oil, is obtained from them. This oil is largely used as a food, and also enters into many industrial processes. The seeds are also ground into meal and fed to cattle.

The hulls give bran, and also a fibre out of which a high grade paper is made. They are also used as fuel and as a fertilizer.

In the manufacturing processes there is much cotton waste produced. This is used in making cheap goods, also for cleaning machinery. Some is chemically treated to make artificial silk. The rags from used-up cotton garments, etc., are collected and sold to paper-makers for the making of paper.

Flax and Its Preparation—

125. Flax is a fibre obtained from the bast or layer underneath the outer bark of the flax or linseed plant. It ranks next to cotton as a commercial vegetable fibre. Russia produces more than half the flax of the world under normal conditions. Belgian flax is the best in the world. Italy, France, Holland, Ireland, Egypt and Cuba are other important producers. A small quantity is grown for fibre purposes in Eastern Canada, Michigan, Minnesota and Washington.

Preparation—Flax grown for fibre must not be cut, but each plant must be pulled from the ground. This must be done before the plant is fully matured or the fibre will be stiff and coarse. The freshly pulled flax is next subjected to a process termed "rippling." This consists in drawing it through a coarse iron comb, the object being the removal of the seed capsules. It is now subjected to the most important process of all, viz.: "retting." The object here is to decompose by fermentation certain

adhesive substances which bind the bast fibres not only to each other but to the central woody portion of the stem. There are three methods of retting:

(1) Cold water retting, which may be carried out in either running or stagnant water.

(2) Dew retting.

(3) Warm water retting.

The Belgian flax is retted in cold running water near Courtrai, in the river Lys. This river retting gives the finest flax available. Stagnant or pit retting is practised in Ireland and produces an excellent fibre, although there is a danger of over-retting and so decomposing the fibres themselves. Dew retting is the practice in Russia and Germany. Warm water retting has not met with much favor. After retting, the stalks are pounded with heavy mallets of a peculiar shape in order to break up the stem but not injure the fibre. They are then "scutched" or scraped with a broad wooden knife until all the woody part of the stem is removed. "Hackling" or combing is then carried out by drawing the fibres through finer and finer combs, until the long "flax" fibres are separated from the shorter ones, which are called "tow." For the best grades of flax this is all done by hand. Machine hackling and scutching are, however, coming more and more into use. The fibres are then spun into long threads and woven into the different fabrics.

126. Cultivation for Fibre and for Seed. Flax is very widely cultivated for its seed, which yields the valuable linseed oil used for paints and linoleum manufacture and many other purposes. If the flax is to be grown for seed its cultivation must be quite different from that of flax which is to be used for fibre.

The flax-grower, then, has first to decide for what purpose his flax is to be used. If for fibre, he sows the seed so that the plants will crowd together and thus produce longer stems. The harvesting must be by hand, and the pulling must take place before the seeds mature.

If he grows for seed he sows more thinly, the object being to allow the plant to become bushy and produce more seed heads. The harvesting is done by machinery since the length of straw is not important.

Consequently, we find flax cultivated for fibre where there is an abundance of cheap labor for the harvest, that is, in older lands and near the crowded centres of population. Flax is grown for seed, on the other hand, in new lands, most often on the first breaking, since new rich soil is the best for flax of this type. Again, the method of harvesting is better suited to regions of scanty populations, since machinery can be used for this purpose.

127. Jute is also a bast fibre. It is obtained from two species of plants belonging to the linden family, which grow in many lands. They are almost exclusively cultivated in Eastern

and Northern Bengal, near Calcutta. Here is found the requisite combination of tropical climate, flooded land, and ample supplies of cheap labor. The process of preparation is similar to that described under flax. Jute fibre is used for the preparation of such cheap materials as sacking, backing for linoleum, and oilcloths. It is also made into carpets and rugs.

A few years ago the chief centre of jute manufacture was Dundee, where the industry has been brought to great perfection. Of late many jute factories have been established in and around Calcutta, and also in Boston and Philadelphia. The cheap labor of India and the freedom from labor troubles have, however, enabled the Calcutta jute manufacturers to control the jute industry. Calcutta is now the greatest centre of jute manufacture in the world, with total exports of raw and finished materials amounting to one hundred million dollars annually. If jute is well prepared it has a high lustre similar to silk. Considerable jute is nowadays, therefore, mixed with silk in order to cheapen the product. The principal use, however, is for sacking. Immense quantities are sent to Brazil each year for the coffee harvest; to Australia for the wool clip, and to the Argentine for the same purpose. The Argentinians also use it to bag their wheat. It is used in the United States for baling cotton. It will be seen, then, that jute is primarily the fibre for cheap fabrics. Jute is also used to make curtains and upholstery fabrics such as plushes.

128. Hemp. This is a name applied to a number of fibres whose principal use is for making cordage. Matthews, the eminent textile chemist of Philadelphia, lists thirty-two plants from which this fibre is obtained. They are all bast fibres. Most of the world's hemp is obtained from Eastern Europe. The so-called "Manilla hemp" is a fibre obtained from a tree which is a near relative to the banana. Hemp is usually known on the market by the name of the country of its origin. Russian hemp is the strongest, Italian hemp the finest. These are both obtained from the true hemp plant. Sisal hemp, Tampico hemp, Manilla hemp, Mauritius hemp, etc., come from plants which are botanically quite distinct from the true hemp.

Hemp seeds are pressed to obtain hemp oil, which is similar in its properties to linseed oil. It is used in soap-making and in paints. Hasheesh, the intoxicating liquor of Arabia, is made from hemp leaves.

The principal uses of hemp fibres are for cordage, ropes, binder twine and other similar commodities.

129. Ramie or China Grass is a fibre obtained from the bast of a plant belonging to the nettle family. It grows in South-Eastern Asia. Recently great improvements have been made in the method of separating the fibre from the bast. In consequence, China grass is now appearing on the market in fine textiles. The fibre prepared by the modern method is clean and

silky. In Europe it is made into fabrics which closely resemble silk. It is used for underwear, velvets, and many other purposes.

130. Cocoanut Fibre or Coir is obtained from the thick outer husk of the cocoanut. The stiffest fibres are used for making brushes, and the longest and straightest for ropes. Coir ropes are valued because they do not rot in salt water. They are also strong and elastic.

The long fibres are also used to make cocoa-matting, and the short curly ones are utilized in stuffing mattresses, etc.

131. Rubber is an elastic substance produced from the coagulated milky juice of nearly one hundred different tropical trees. The most important are the Brazilian or Para rubber tree (*Hevea brasiliensis*), the Central American rubber tree (*Castilloa elastica*), the East Indian rubber tree (*Ficus elastica*), and the many species of rubber vines found in Africa. The Brazilian tree is the most important of all these and produces the very finest quality of rubber. Rubber has been known to Europeans for more than three centuries. Yet until the beginning of the nineteenth century it had only a few casual uses, the water-proofing of fabrics and the erasing of pencil marks being the most important. The extensive use of rubber dates from Charles Goodyear's great discovery of "Vulcanizing" the raw rubber. This process consists of adding sulphur to the rubber and strongly heating the mixture. This causes the rubber to lose its stickiness and also to withstand extremes of heat and cold without spoiling. If considerable sulphur be added the rubber loses its elasticity and becomes a solid, black substance known as "vulcanite" or "ebonite." This substance is hard and strong. It will not burn, nor will it conduct electricity.

These properties make rubber an extremely useful substance having many industrial applications. Since Goodyear's discovery the use of rubber has increased by leaps and bounds, until today it is one of the most universally used materials in industry.

Until a few years ago, the principal sources of the raw rubber or "caoutchouc" were the forests of Brazil and of the Congo Free State. Today all this is changed and the main source of supply is from British Malaya. The story of how this was brought about is one of the romances of modern commercial enterprise.

The rubber from Brazil and the Congo is a wild rubber, that is to say, it is gathered from the trees of the forests and not from trees planted and cultivated by man. Until 1910 the forests of the Amazon basin produced more than half the rubber used in the world. The balance came principally from the Belgian Congo and the west coast of Africa. Considerable quantities were also sent from India and the Central American republics. The forests of all these countries are hot and extremely unhealthy. White men cannot work in them and retain their health. Therefore the rubber is gathered by the natives.

In addition to the unhealthy climate, the native rubber-gatherers have to struggle against great difficulties in making their way through the dense jungle in their search for the trees. The luxuriance of the vegetation makes transportation difficult since it is almost impossible to keep trails open. In consequence they experience great difficulty in getting the crude rubber to the market. The trees having been located, the rubber-gatherer endeavors to get a line of them, so that he can work out from his market point in a circle back again to it, tapping the trees and collecting the "latex" (as the coagulated juice is called) as he goes. In fact he works on a plan very similar to that of a fur-trapper operating his trap line in the woods of Northern Canada. The process of collecting and preparing the raw rubber is as follows:

The tree is tapped and the latex caught in a vessel. This sap is then collected into a larger vessel, and coagulated in the smoke of a fire made of palm nuts. This coagulated juice must now be cured in order to convert it into a good quality of solid rubber. In order to do this a fire is kindled and a clay funnel placed over it. A thick smoke issues from the funnel. The rubber-collector dips a paddle into the coagulated juice and holds the paddle with its adherent mass in this smoke until the rubber stiffens. He repeats the operation until several layers have been added. When he has a thick enough mass he slits it up and peels it off. This peeled off mass is now dried in the open air and is ready for market. A good collector will cure about five or six pounds of rubber in an hour. He then goes to his next stand of trees and repeats the operation. The cured rubber is carried on his back in small bundles or bales of about 150 pounds each. Transport by animals is out of the question, as they require a wider trail than can possibly be kept open in this region of quick growth.

After the rubber has been gathered and cured it is brought down to the rivers to various collecting stations. It is brought from all parts of the forest in native canoes to the larger river ports and from there it is carried in river steamers to the sea ports. Para is the most important of these great rubber ports in Brazil, and Boma in the Congo Free State. With the invention of the modern automobile and the phenomenal expansion of the automobile industry the demand for rubber outgrew the supply from the forest. If this industry was to flourish, other means of obtaining rubber had to be found. That was the problem facing automobile manufacturers.

The problem has been solved by British botanists in a brilliant manner through the cultivation of the Para rubber tree (*Hevea brasiliensis*) in great plantations throughout Ceylon and the British East Indies.

Plantation Rubber. The idea of cultivating rubber in the British overseas dominions was first initiated by the late Lord Salisbury, then Secretary of State for India. About this time

two industries were clamouring for regular supplies of rubber. These were the rubber boot and shoe industry and the then new electrical industry. Lord Salisbury held the opinion that if the seeds of the Para rubber tree could be obtained they might be made to grow in Ceylon and the East Indies, and so provide a new industry for the crowded population of those lands.

He communicated with Sir Joseph Hooker, the great botanist, who at that time was director of Kew Botanical Gardens near London, England. In 1873 the British Government authorized the despatch of an expedition to the Amazons to procure seeds and plants for cultivation in India. This expedition procured some hundreds of seeds and plants of Para rubber. They were brought to Kew, where they were planted in the tropical conservatory. Only about a dozen plants were raised. Six of these were sent to Calcutta. They all died. In 1876 the Kew authorities communicated with Mr. Wickham, then cultivating Para rubber trees at Santarem on the Amazon river. He chartered the S.S. Amazonas of the Inman line of steamers and shipped some 5,000 rubber seeds by her to Liverpool. The ship arrived on June 14th, 1876. A special night train from Kew was sent to meet the ship, and a fortnight later there were many rows of the young plants growing in the conservatory at Kew. Of these 1,919 were sent to Ceylon; some to Perak in the Malay Peninsula. Of those sent to Ceylon, the greater number survived. Later on plants were successfully reared in Singapore. From these beginnings has been developed the enormous rubber business of the British East Indies.

About the year 1890 the consumption of rubber was greatly increased by the adoption of the pneumatic tire for bicycles. The demand for rubber rose by leaps and bounds. Shortly after the automobile made its appearance with its still larger demand for rubber. The forests of Brazil were no longer able to supply the demand for more and still more rubber.

In the meantime the British botanists had been quietly working out the idea advanced by Lord Salisbury in 1873 and finally they brought into being those splendid plantations in Ceylon and the East Indies.

While today Ceylon produces large quantities of rubber, the great bulk of the plantations are in Malaya. Singapore has replaced Para as the great rubber port of the world. In 1910 Para exported more than half of the world's supply, but today the plantations of the south-eastern area produce more than ninety per cent. of all the rubber used.

Uses of Rubber—

Rubber is one of the most important of modern commodities. It seems almost impossible to produce too much, since new uses for it are continually being discovered. Its principal use is for tires. The automobile, the bicycle, the horse-drawn carriage and baby carriage all use large amounts of rubber for their tires. Hoses for various purposes are made from it. Rub-

ber packing for engines, valves, and pumps, is made in immense quantities. Footwear of many varieties, raincoats, sponges, bathing caps and suits, surgeons' gloves, and a thousand other articles, are manufactured from rubber.

In electrical appliances, rubber is almost invaluable. Its non-conducting property renders it invaluable to the electrician. Its use as a floor covering is steadily increasing, and it is said that before long footpaths will be paved with it.

Synthetic Rubber—

Recently a method of preparing a synthetic rubber from raw starch has been discovered. At the present time there are difficulties but within a few years these will likely be brushed aside. We shall then see rubber produced by the chemical engineer which is absolutely identical with that produced by nature. It is said that large-scale production will enable rubber to be produced synthetically at less than sixty cents per pound. The present price of plantation rubber is about one dollar and twenty cents per pound.

Rubber Manufacturers—

The greatest manufacturer and consumer of rubber is the United States. Great Britain and Germany take second and third place respectively, while Canada ranks fourth among the rubber-manufacturing nations.

Rubber-manufacturing is one of Canada's great industries. It is centred in the Province of Ontario. In 1922 (the latest date for which there are official statistics published) there were twenty-four establishments operating in Canada. Of these twenty were in Ontario, three in Quebec and one in British Columbia. The value of materials used by them was over fourteen million dollars, while the value of their finished products was almost thirty-one and a quarter million dollars.

The principal articles produced by these factories and their values were:

Tire casings	$19,519,208
Inner tubes	2,468,111
Solid auto truck tires	476,735
Rubber Footwear	1,556,738
Rubber belting, rubber hose and miscellaneous	7,202,446

The principal Canadian rubber exports in 1922 were:

Tire casings and inner tubes	$ 5,925,120
Rubber boots and shoes	2,089,484

The total exports of rubber goods were:

1922 ... $4,862,008 1923.....$8,455,141 1924.....$9,098,918

Canadian-made tires go principally to Great Britain and the British possessions.

Raw Rubber Statistics—

	In thousands of tons		
	1920	1921	1922
United States	118	117	289
Great Britain and Ireland	25	20	20
France	17	15	28
Germany and Austria	13	22	29
Italy	6	4	5
Japan	6	23	13
Canada	9	11	9

Chief Producers of Plantation Rubber, 1922—

Malaya	189,750 tons
Ceylon	41,250 "
Dutch East Indies	84,150 "
South India and Burma	6,600 "
Other Producers	8,250 "

The Brazilian production of rubber for 1922 was 19,855 tons; and in 1923 it declined further to 17,995 tons.

It will be noticed from the above figures that the huge rubber industry of the United States is almost entirely dependent upon British-grown rubber. This is causing great anxiety among American rubber-men, who are advocating plantations in the Philippines and further efforts in the synthetic production of rubber in order to offset this condition.

132. Tobacco.

Wide Range of Cultivation—

Not many of the great commercial plants are grown over so great a range of the earth's surface as is tobacco.

It may be grown successfully on any agricultural soil. The plant is sensitive to frost, but the short season required for maturing the crop enables it to be grown in many temperate latitudes.

The commercial value of the crop is more affected by the soil and climatic conditions under which it is grown, than is that, perhaps, of any other great commercial crop. There are several varieties of tobacco grown, the principal ones being: (1) cigar leaf, (2) cigarette leaf, (3) manufacturing types, (4) export type.

The finest cigar leaf comes from Cuba. Turkey produces the world's finest cigarette leaf. The manufacturing types are principally American and are used to make cigarettes, chewing and plug tobacco. The export type is principally made into snuff.

The tobacco-growing industry is peculiarly an intensive type of agriculture. The tiny black seeds are sown in seed beds and the tiny plants transplanted either by hand or by machinery. Once in the field they require constant care and much hand labor is necessary to protect them from cut worm, leaf worm and stalk worm. Then again the bloom must be picked off by hand, in order that the energy of the plant may be directed towards leaf-making rather than seed production. For the same reason

all suckers and side shoots must be pulled off. The labor of picking, curing, sorting, grading and packing is laborious and requires skill.

The greater amount of the labor requires care and watchfulness rather than strength, hence women and children are extensively employed in tobacco culture.

Tobacco is, therefore, rarely grown on an extensive scale, but is usually grown by the members of the farmer's family, who care for small fields. Some varieties are grown entirely under enormous shades of cheesecloth.

The United States is the world's greatest tobacco-grower. It is also grown in Eastern Canada, where its manufacture constitutes an important industry. Cuba is also an important producer of cigar leaf tobacco. The Cuban product leads the world for excellence of quality in this grade of tobacco.

World's Production—

United States	55.0%
British India	17.9%
Russia	9.0%
Philippine Islands	5.3%
Japan	3.9%
Dutch East Indies	3.6%
Greece	2.4%
Others	2.9%

Tobacco manufacturing is carried on by two distinct methods—

(1) The small factory employing entirely hand labor.

(2) The large-scale modern factory, utilizing complex modern machinery.

Formerly the best cigars were hand-made and in the cigar industry the small factory was almost supreme. Lately, however, there has been a tendency to combine into larger shops and to use some machinery. This newer condition has arisen from the following causes:

(1) The necessity of standardizing the product.

(2) Cheapening production by utilizing machinery where possible to supplement the expensive hand labor.

(3) The necessity for more effective advertising.

(4) The difficulty of keeping cigars in good condition.

(5) Their bulkiness adding to the cost of transportation.

The result is that cigar-making is rapidly becoming more and more concentrated in the larger cities and in large shops instead of being scattered in a large number of small establishments.

The principal products of the large-scale factory are cigarettes and smoking or chewing plugs. Snuff is also a machine-made product.

In Canada the industry is principally centred in Quebec. There were 108 establishments engaged in tobacco manufactur-

ing in Canada in 1922, the value of their products amounting to over forty-six million dollars. Of this total Quebec contributed over forty-three million dollars.

World's tobacco consumption in pounds per capita is stated to be:

Holland	7.5	pounds	per	capita
Belgium	6.2	"	"	"
United States	5.7	"	"	"
Germany	3.5	"	"	"
Canada	3.38	"	"	"
Great Britain	2.1	"	"	"

It is also stated that the number of cigars made annually in the United States exceeds seven billions, and that in 1921 the output of cigarettes in that country amounted to approximately sixty-five billions.

133. Tea. Tea is the dried leaves and young shoots of a hardy evergreen shrub native to the mountains of Southern China, Indo-China, Burma and Assam. It appears to have first been used by the Chinese. Until comparatively recent times the world's supply of tea all came from China. In recent years the principal supply has been obtained from British India and Ceylon. The tea plant is very hardy and not at all sensitive to frost. It is, however, very averse to stagnant water. These two conditions make it primarily a hill crop. Tea is grown on a wide range of soils and topography. In China poor soils and steep slopes are mainly used. In Assam virgin forest land on valley bottoms is preferred. The principal requirement seems to be good drainage. Extremes of temperature and lack of rainfall having a tendency to check rapid growth, tea is rarely a profitable crop in such regions. Otherwise favorable geographic conditions are not hard to find. But for all that the Orient remains the principal producer of tea. The reasons for this are both economic and geographic, and are found in several factors concerning the growth, cultivation ,and preparation of tea for the market. The principal requirement in tea cultivation is an abundant supply of cheap and skilful labor. Nowhere is this so readily obtained as from the teeming populations of the East. Again, long growing seasons and abundant moisture and good drainage facilities are necessary to supply the quick growth of leaves, so that many pickings may take place each year. Nowhere are these conditions so perfectly developed as in the monsoon region of South-Eastern Asia, with its many mountain ranges, heavy rainfall and warm climate.

Varieties of Tea—

Varying environmental influences have resulted in many varieties of the tea plant, of which the large-leaved Indian varieties and the small-leaved Chinese types are the most distinct.

The teas of commerce are classed as black and green teas. These were formerly thought to be products of quite distinct

shrubs. They are now known to be obtained from the same plant. The difference between them is simply due to the method of curing the leaves.

Outline of the process of producing black and green teas:

Black Tea—Leaves picked; withered in the sun; rolled until soft; fermented; fired; sorted.

Green Tea—Leaves picked; withered in pans over a charcoal fire; rolled until soft; withered again; sweated in bags; slowly roasted.

Mechanical devices have largely supplanted hand-labor in tea manufacture, but no devices for pruning, weeding and picking the crop have been found satisfactory; hence the great necessity for abundant supplies of cheap labor. The pruning and weeding are usually done by men ,and the picking by women and children. In China and Japan there are several harvests each year. In Ceylon, where there is practically no winter, picking takes place about every ten or twelve days all the year round.

China is the world's largest tea producer, but not the greatest exporter. Statistics of acreage and production are not available, but the known exports, together with the huge local consumption, call for a tea crop in China about eight times greater than that of India. East Central China is the region of greatest production. The supply is largely produced in small gardens; for in China tea is not a plantation crop as it is in India and Ceylon. This causes the Chinese teas to have a lack of uniformity of grade.

The tea acreage of Japan is not great and the crop is generally of an inferior grade. The famous Oolong tea is, however, grown on the terraced slopes of the island of Tai-wan (formerly called Formosa).

India and Ceylon are the largest tea-exporting countries. In India the principal regions are in Assam and Darjeeling, in Bengal. Tea is also grown on the western slopes of the Cardamon and Nilgiri Hills in the extreme south of India. Ceylon has a great advantage in tea production over both China and Assam. Here the warm winters due to its southerly position and the combination of wet monsoons in both summer and winter allow picking all the year round at intervals of ten or twelve days. The tea lands of Ceylon lie chiefly on the mountain slopes up to an elevation of 6,000 feet.

World's Tea Exports—

Four-year average, 1918 to 1921:

British India	48%
Ceylon	26%
Dutch East Indies	12%
China	8%
Japan and Tai-wan	6%

British India and Ceylon produce 74% (or nearly three-quarters) of all tea exported.

Tea is being cultivated in Natal and Fiji, but their exports are as yet negligible.

World's Tea Consumers—

The three leading countries in tea imports are, in order, Great Britain, Russia, and the United States.

By far the greatest proportion of tea is consumed by Great Britain and the essentially British-settled overseas Dominions of the Empire.

134. Yerba Mate or Paraguay Tea. This so-called tea is made from the leaves of a small tree growing wild in Paraguay and Southern Brazil. It is a very popular beverage in Paraguay, Uruguay and the Argentine. Southern Brazil exports millions of pounds annually to Argentine and Uruguay. The direction of the trade is down the Parana river to Buenos Aires. At present this "tea" has only a local importance in the international tea trade of South America. An effort is being made to develop a market for it in the United States.

135. Coffee is the seed of a plant that can only be grown in the tropics. It originally came from the province of Kaffa in Arabia. The name is supposed to be a corruption of Kaffa. The plant is now grown in almost all parts of the tropical world. It thrives best at an altitude of a thousand feet or so. The plant is a wide-spreading shrub about twelve to fifteen feet tall. The berries are bright red and are produced in small clusters in the axils of the leaves.

The annual consumption of coffee is now over two billion pounds. Of this immense crop Brazil produces nearly three-quarters, and the United States consumes about half the world's production.

While the coffee plant will grow in nearly all tropical lands it is really very exacting in its soil and climatic requirements in order to be at its best. These requirements are:

(1) It must have a frost-free or nearly frost-free climate, because heavy frosts kill the plants.

(2) It does best on the cooler outer margins of the tropics, where insect pests and fungus diseases are not so prevalent.

(3) It grows best on the hills and hill slopes, since they have good soil and frost drainage.

(4) It thrives best in decayed volcanic soils, which are peculiarly rich in iron and potash.

(5) There must be a dry season during which the berries may be spread out to dry in the open air.

Nowhere are all these conditions so well combined as in South-Eastern Brazil.

Growth and Production of Coffee—

As has been stated before, the coffee tree grows to a height of about fifteen feet. In coffee plantations it is usually pruned back to from five to eight feet so as to facilitate the picking of the berries. The berry has the appearance of a red cherry and usually encloses two grains in its pulp. After picking, the berries are put into tanks of water and allowed to ferment a little. They are then passed through a pulping machine which breaks up the fleshy part of the berry. This pulp is now removed by washing in water baths. The seeds, which are still covered with a parchment-like skin, are now sun-dried, and the skin removed by a rolling machine. The coffee is now ready for export, but must be roasted before using. This is usually done near the point of consumption, since the aroma of coffee is at its best when the bean has been freshly roasted.

Coffee-growing Areas—

South-Eastern Brazil has the greatest acreage and production. Java, Colombia, Venezuela, Central America, Mexico, Haiti, Porto Rico, Arabia and Uganda all produce coffee.

The Arabian and Java coffees are most highly esteemed in the Old World, while Brazilian coffee is liked best in the New.

Coffee Production of the World—

Brazil	70%
Central America	8%
Colombia	5%
Venezuela	4%
West Indies	4%
Mexico	3%
All others	6%

The leading coffee-importing nations in order are the United States, Germany, the Netherlands, France, Belgium, Sweden and Italy. Santos and Rio Janeiro in Brazil are the leading coffee ports of the world. Santos ships far more coffee than any other port.

136. Cocoa. Cocoa is prepared from the seeds of the "cacao" tree. This tree is often confused with two other trees of similar name, viz.: the "coca" tree, which gives us the drug cocaine, and the cocoanut palm.

Unlike the two other tropical trees which give us the favorite beverages of tea and coffee the cacao tree is a native of the New World. The tree grows wild in the hot, steamy forests of the Orinoco and Amazon basins. The whole of the cocoa of commerce is, however, the product of cultivated trees.

The cacao tree is about twenty-five feet tall, has large glossy leaves, and bears its flowers directly on the branches and trunk. This method of flowering, unusual to us, is quite common in the rainy equatorial regions. The large pods which appear after flowering look as if they were attached to the tree artificially.

Cacao pods are from six to nine inches long and each contains about fifty seeds. These seeds form the cocoa of commerce.

The conditions necessary for the growth of the cacao tree are extremely exacting. So much so that its production is entirely restricted to the region of equatorial calms or the doldrums. It is not found as a commercial plant outside a belt of about twenty degrees on each side of the equator.

The trees must have a well watered and well drained soil, as well as plenty of rainfall. They are very delicate and while young cannot stand the strong direct rays of a tropical sun. The planter, therefore, grows them under shade trees. The shade tree usually used is the banana. The heavy fruit of the cacao tree and its peculiar manner of attachment to branches and trunk render it very vulnerable to high winds. Hence cocoa culture is limited to the belt of equatorial calms where winds are very infrequent. The trees will not thrive unless the temperature is about eighty degrees or more, and they require about seventy-five inches of rainfall a year. Such a combination of factors is unknown outside the doldrums region. The climate of such regions is usually unhealthy for white races; native labor is therefore almost entirely used in the cultivation of cocoa.

The chief cocoa-producing areas are Ecuador (where cocoa forms the largest export), the east coast of Brazil, the Caribbean coast lands, West Africa, and the Dutch East Indies. The use of cocoa and chocolate has grown rapidly, and the value of cocoa entering into trade now reaches a total of over twenty million dollars.

Preparation of Cocoa and Chocolate—

The pods are gathered by cutting them off the tree with a knife attached to a long pole. They are then collected and taken to some convenient place, if possible, near running streams. Here the pod is opened, usually with a cutlass, and the seeds taken out. When removed from the pod the beans are covered with a slimy, gummy substance, and are very bitter. The covering is removed by sweating. Sweating consists of wrapping them in green leaves and placing them in a close room, or in pits. A slow fermentation then takes place. This removes the bitter taste. The beans are then spread on trays, covered with red mud, and left for a day. They are then rubbed with the bare hands or trodden with the bare feet so as to remove the gummy matter. Finally they are laid out to dry and turned frequently. The cacao beans are now ready for export to the chocolate and cocoa factories.

In Guayaquil the cacao beans are dried in the streets of the city and the whole air is redolent with the smell of them.

Manufacture—

When received by the manufacturer, cocoa is cleaned, sorted and roasted. The roasting must be carefully done or the fine flavor will be ruined. The roasted seeds are next run through

a machine called the cracker. This frees the outer shell from the inner parts. These inner parts are called cocoa nibs. The shells, nibs and germs are then separated from each other by sieves and a special machine. The shells are ground and sold to makers of cheap beverages. The cocoa nibs are used to make either chocolate or cocoa.

Preparation of Chocolate—

The cocoa nibs are ground into a paste by a series of revolving stones, arranged in pairs and slightly heated to assist in liquefying the cocoa. While in a semi-fluid condition, the paste is moulded into cakes and allowed to harden.

This is the bitter chocolate. If sweet chocolate is required the ground nibs are passed into a mixer, and finely ground sugar, spices, and flavoring matter are thoroughly incorporated. Sometimes condensed or powdered milk is also added. This is the well known "milk chocolate." It was first produced in Switzerland.

Preparation of Cocoa—

The cocoa nibs are very rich in oily matter. This sometimes makes up nearly fifty per cent. of the weight of the bean. This oil makes cocoa too rich for ordinary purposes. It is, therefore, removed, after the grinding process, by subjecting to heavy pressure in hydraulic presses. This removes about 60% to 70% of the oil. The mass is then allowed to cool, after which it is ground to a powder and packed.

The oil is clarified and allowed to solidify in moulds. This forms the cocoa butter of commerce. This fat has the property of not turning rancid very readily. It is used in pharmacy, candy-making, and in the preparation of cosmetics, perfumes, pomades, and soft toilet soaps.

137. Spices are various vegetable products, fragrant or aromatic, and pungent to the taste. They are used in cookery to season food and to flavor sauces, pickles, etc. The commonest spices are ginger, cinnamon, nutmegs, cloves, vanilla, mustard and pimento. They have no real value as food, but are greatly prized for flavoring purposes. They are specially interesting in the history of commerce since it was the search for them which led to the great era of discovery about the end of the fifteenth century. For a considerable period they were of dominating importance in the trade of the world. In those days Arabia was always regarded as the land of perfumes and spices, as various literary references of the period show. Really very few spices came from Arabia, but the fact was that the trade in spices was in the hands of Arab merchants who brought them from India and the East coast of Africa to Europe. These merchants jealously guarded the secret of the source of their trade. Spices in the middle ages were brought by sea, along with fine cottons, etc., from India, Africa and the east, to Aden, and from there to

Alexandria, which was then the great entrepot port of the world. Subsequently the Venetians long held the carrying trade for these products into Europe. Then it passed into Portuguese hands. The Spaniards made great efforts to secure this lucrative business, but met with indifferent success. Later this trade passed to the Dutch, and they, in turn, were forced to yield it to the British.

Almost all spices, excepting mustard, are produced in the tropics. The commercial production of spices is concentrated in fertile spots in the great centres of densest tropical populations. This is due to the necessity for patient, skilled, and cheap labor.

138. Ginger is the underground stem of a tropical plant. It requires a hot climate, a rich soil, and a good supply of moisture. It is grown in a similar manner to potatoes, that is, by planting pieces of these underground stems. It is harvested by digging, about ten months after planting. The root stems are full of joints and very solid and tough. They are brown outside and pale yellow inside. After removing the earth from them, they are well washed, and the smaller roots cut away. They are then dried in the sun. Large quantities are grown in India. The plant was introduced into the West Indies, and Jamaica now produces a particularly fine variety. It has been carried from there to South America. Ginger is also grown and exported from West Africa, China, Japan, Cochin-China and North Queensland.

139. Cinnamon is the product of an evergreen belonging to the laurel family. In its native state it grows to a height of from forty to sixty feet, but on plantations it is pruned back and kept much lower. The plant is propagated from seeds and from cuttings. It requires a sandy soil and abundance of heat and moisture.

The spice is obtained by peeling the bark from the long shoots which grow out after the trees are pruned. This bark is dried, made into bundles and sent to the manufacturers, who pulverize it. The flavor is due to an essential oil. The principal sources of supply are Ceylon and the Seychelles. From these islands cinnamon culture has been introduced into the West Indies, Senegal, and India.

140. Cassia is the bark of a somewhat similar plant. It is much like cinnamon, but of inferior quality. It is used largely to adulterate the Ceylon cinnamon.

141. Caraway Seed. Really the dried fruit of a biennial shrub which grows in Continental Europe, particularly in the south and central parts, caraway seed is used to flavor cakes, bread, and other confections.

142. Nutmeg. Nutmeg is the fruit of a bushy evergreen growing about thirty to forty feet high, found growing wild in

the Banda Islands in the Dutch East Indies. The nutmeg tree requires heat, moisture and a well-drained soil. The young tree must be shaded. The seeds are sown in nursery beds and take about three months to germinate. The trees blossom when five or six years old. They carry male and female flowers on separate trees. The nutmeg tree is considered to be at its best when about twenty years old, but it bears for about one hundred years. Once the plantation is established nutmeg trees need but little attention, since no weeds grow under them. The fruit is mostly allowed to drop off the trees of its own accord, but in some countries it is harvested by means of a hook attached to a long pole. There is a small basket near the top of the pole to catch the fruit as it falls. A good bearing tree produces four or five thousand nuts every year. The chief harvest is in the autumn, but a smaller crop is also gathered in the spring. Sources of supply: The Banda Islands and many other East Indian Islands, India, Ceylon, Malaysia, and the West Indies, especially the island of Grenada. The West Indies has now the most extensive plantations and will soon become, it is expected, the largest producer.

Singapore and Penang are the greatest ports for nutmeg.

Mace is a spice obtained from the husk of the nutmeg. The chief use of nutmeg is as a spice. It is, however, also used in medicine, and in large quantities it acts as a narcotic. An essential oil is distilled from both the mace and the nutmeg, which is extensively used in making perfumed soaps.

143. Cloves are the unopened calyxes of an evergreen tree belonging to the myrtle family. It grows to a height of about forty feet. The calyx of the clove-tree flower is about half an inch long and is very hard. It gradually changes in color from green to bright red. At this stage, before the petals have opened, the crop is harvested. In Zanzibar each clove is picked by hand, moveable stages being erected to allow the pickers to reach the upper branches. In other places the usual method is to beat or shake the tree, when the cloves readily fall to the ground. The latter are then dried in the sun, and during this process the color again changes from red to dark brown. When distilled, cloves yield an essential oil known as oil of cloves.

This oil is pale yellow in color and is used in soapmaking and perfumery.

Sources of Supply—

Near Celebes are five little islands known as the Moluccas, or Clove Islands. These islands are usually regarded as the home of the clove tree. When the Dutch took them from the Portuguese, they compelled the inhabitants to destroy the trees, so that the Dutch plantations of Amboyna and Banda might have the monopoly of the clove trade. The trade now flourishes in nearly all the East Indian Islands. In 1770 it was carried by the French into Reunion and from thence it has spread to Zanzibar and Pemba. These two islands now produce the largest

supply of cloves. Besides Zanzibar and Pemba, Penang, India, Ceylon, and the West Indies produce and export cloves.

144. Vanilla is obtained from the pods of two climbing orchids native to the West Indies and Central America. Both kinds have flat leaves, and a fleshy climbing stem that hugs tree trunks or other supports. It requires a hot, moist climate, but too much rain while the pods are ripening causes them to drop off. This rather limits the localities suited to its cultivation. The pods are about the thickness of a man's thumb, and from five to seven inches long. They are yellow when ripe. The pods are cured by dipping in boiling water or by fermentation. This process of curing is a difficult one and requires long experience to obtain the best flavors. Although the plant is a native of Mexico, it is but slightly cultivated there, the Orientals having captured most of the trade. The principal producers and exporters are the Islands of Tahiti, Reunion, Mauritius and Seychelles. Tahiti produces about one-half of the world's supply available for export.

145. Mustard is the finely powdered seed of a plant belonging to the same family as the beet and turnip. It is much used in England. The plant appears to thrive best in a foggy climate. Western Russia, Holland and the counties of Essex and Cambridge are the principal Old World mustard regions. The mustard plant is also grown at Lompoac near Santa Barbara in the United States, and around Bombay in India. The Indian mustard is, however, of an inferior quality.

146. Pimento or Allspice or Jamaica Pepper is the spice obtained from the seeds of an evergreen tree belonging to the myrtle family. The tree has a smooth, greyish bark, which it sheds each year; and it grows to a height of about thirty feet. The seeds are enclosed in a small berry about the size of a pea. Pimento plantations are called "walks." Pimento trees require heat and not too much moisture and a well-drained limestone soil or a loamy soil. The trees begin to bear when about seven years old. They reach their highest perfection about the twentieth year. The harvesting of the berries takes place in July and August. Boys go up in the trees and break off the twigs bearing the fruit. They throw them down to the women and children who pick off the berries and dry them in the sun. In a few days the berries change in color from green to dark brown, and are then ready for packing and export.

Sources of Supply—

Jamaica is practically the only exporting country, but pimento is cultivated in several tropical islands. The word pimento is derived from the Spanish word "pimienta" which means pepper. In America the name is commonly applied to pepper and other varieties of spice.

147. Pepper. Although this spice is not listed in the outline of the course for Geography I, it is of such great importance that it must not be overlooked here.

Pepper is the most important of all the spices. The quantity exported exceeds that of all the other spices combined. Singapore is the great exporting centre. There are two kinds of pepper, viz.: white and black. These are both produced on the same vine. The pepper plant is a climbing vine with soft stems and leathery leaves. It bears flowers in much the same manner as red currant bushes. The fruit when ripe is a red berry about as big as a pea. The harvesting is begun when the berries at the base of the stems turn red. After picking, the berries are separated from the stalks by hand rubbing and winnowing. When dry they are black and wrinkled. These berries form the "black pepper" of commerce. White pepper is obtained by soaking the berries in water and removing the skins. They are then dried.

Pepper requires a hot, moist climate and a rich soil, which must be well drained. The best pepper in the world comes from the Malabar coast of India. Other sources are the Malay Peninsula, Bombay, Ceylon and Kenya Colony.

There are many other spices produced which constitute important articles of trade with the tropics, such as cardamon, coriander, anise, and pistachio.

Roots and fruit juices are also used for flavorings, e.g., sarsaparilla.

Many of the modern flavorings are made artificially in the chemical laboratory. Of these vanillin is important. It is claimed that this product of coal tar will eventually ruin the vanilla plantation industry. So far, however, the natural vanilla is so much superior to the coal tar product that it has been able to hold its own against the synthetic variety.

148. Vegetable Oils and Nuts.

Olives and Olive Oil—

The olive tree and its fruit have been noted before (see section 106). Olive oil is obtained by pulping the olives in a grinding mill and removing the stones. The resulting pulp is then placed in canvas or felt bags and pressed in great hydraulic presses. (For description of hydraulic presses see General Science and Physics Texts.) There are two kinds of olive oil produced by this process, viz.: cold pressed and hot pressed. Cold pressed oils are produced by simply pressing the pulp without heat. Hot pressed oils are produced by heating the meal after cold pressing and then subjecting it to further pressure.

Cold pressed oils are the best. The hot pressed oils are quite inferior and are used in soap-making ,etc.

Olive oil is also obtained by an extraction process. The olives are first ground to a pulp and then treated in a closed vessel with a suitable solvent, such as carbon disulphide or petroleum naphtha. After extraction the solution of oil is drawn off and

the solvent recovered by distillation. The process gives a larger yield of oil, but the oil is contaminated with resins and coloring matter. This process is, therefore, not greatly used. Another objection to its use is that it leaves too little oil in the meal, so that the latter cannot be used for cattle food as in the case of the expressing process.

Italy, France and Spain are the leading producers. The French Mediterranean colonies of Tunis and Algeria also send olives to Marseilles. South Australia and Queensland are rapidly adopting the olive tree for cultivation on their arid lands and will soon be large-scale producers. California is also breaking into this market.

149. Palm Oil Industry of West Africa. The palm which yields this oil is a native of the rain forests of Western Africa, which extend from Cape Verde to the French Congo. It cannot thrive on a sandy soil, so that it does not appear until about three miles inland.

When full grown the tree is about sixty feet high and has the long, straight leaf, and the scarred trunk crowned with a feathery mass of foliage, which are typical of palm trees in general.

The spreading foliage at the top is formed of large, pinnate-shaped leaves from eight to fourteen feet long. The flower stalks grow out from a main branch. Each of these branches carries about 200 to 250 flower stalks. These flower stalks bear from eight to ten flowers each, thus producing in all a cluster of roughly 2,000 flowers. Of these about 500 make perfect fruits. The rest produce fruit also, but without kernels. Both kinds of fruit, however, are very rich in oil. During a year a tree will produce about five or six of these great bunches. Each bunch weighs about thirty pounds. The fruit is collected by natives who traverse the hot, moist, unhealthy forest. The tree is so tall that it is difficult to tell if the fruit is ripe; so the collector watches the ground for half-eaten fruits dropped by parrots, monkeys, etc. On finding these he knows that the fruits are ripe. With the help of a rope loop round his feet, or sometimes round his waist, he climbs the branchless stem, and lops off the fruit with a huge knife. The bunches are slung on poles and taken to the villages. Here the oil is extracted in a very primitive way. The method is as follows: The bunches are piled and covered with leaves until the fruits are easily picked from the stalks. The fruits are next placed in a great iron kettle or tank, with some water, and boiled. As soon as they are soft, they are shovelled into round wooden tubs, and pounded with wooden pestles until the pulp is separated from the stones. The oily mass is emptied now on to long narrow sloping trays and the stones picked out. These are washed in tubs of water. The women then squeeze the oil out of the pulp with their hands. The oil collects at the lower end of the tray. The pulp is thrown away and the oil poured into kerosene tins. Each tin holds five gallons. The tins are placed in pairs on a board and carried on

the heads of the men to the nearest collecting market. From this place they are transported down the rivers to the coast towns or factories. From these points the oil is exported. The palm nuts are washed free from adherent pulp and cracked between flat stones. The kernels are picked out and exported as they are. The oil in them is expressed by hydraulic pressure in the country importing them.

But this method of extraction is very wasteful of oil. And demand for oil is now so great that all the resources and energy of the producers are being sorely pressed to keep up the supply. With a view to relieving this strain, Lord Leverhulme, of the Sunlight Soap Company, acquired concessions of land in West Africa. Here he planted palm trees in great plantations, and as the producing stage is reached, the oil is expressed by modern machinery. This venture has already resulted in an increase in the yield of this valuable palm oil. If the plantation method proves successful it will repeat the victory over rubber, and demonstrate to the world that the spirit which made the British Empire is not yet extinguished in spite of what its rivals may say.

Palm oil is the oil obtained from the pulp of the fruit and is used in making soap and candles. It is a valuable lubricant for the axles of railroad engines and cars. It is also used in the manufacture of tin-plate. Palm-kernel oil is the oil expressed from the kernels of the nuts. This oil is white, whilst the palm oil is reddish-brown. Palm kernel oil is being used very largely for making margarine and other similar fat substitutes used as foods. The cake left after expressing the oil is very rich in fat and is a valuable fattening food for animals.

West Africa is the great source of supply and Lagos the principal exporting port, but palm oil is shipped from nearly all the ports along the Bights of Biafra and Benin, especially those on the various distributaries of the Niger River. The oil palm grows in Central Africa, the West Indies, and all the Guianas. The exports from these lands are, however, very small compared with the West African production.

Liverpool is the chief importing centre for the British Isles, Marseilles for France, and Antwerp for Belgium and the Rhine Valley. Hamburg is also an important importing port. In America, Philadelphia and Boston are the chief importing centres. The American packing industry, however, provides so much inferior fat for soap-making, that American imports of palm oil are small in comparison with the European totals.

150. Cocoanuts, Cocoanut Oil and Copra. The cocoanut is the fruit of a tall palm which can only grow along the seashores of tropical lands. This palm appears to be quite incapable of growing out of reach of salt-laden air. In appearance it resembles the other tall palms in having a tall, rather slender branchless stem topped with a feathery crown of foliage. The

cocoanuts are produced from the time the trees are about six years old, and the trees continue to bear until they reach the age of sixty to seventy years.

The flowers grow along stalks, which are clustered around a main stem. This stem is enclosed in a spathe, very like that of an arum lily. About twenty nuts are produced inside each spathe. The tree forms about twelve spathes each year, so that the average crop is about two hundred nuts per tree per annum. The cocoanut when it comes from the tree does not look like the familiar nut exposed for sale in the stores. The nut itself is enclosed in a thick fibrous outer case which is triangular in shape and about two or three inches thick. The whole thing is about the size of a football.

Nowadays the trees are cultivated in plantations. The principal sources of supply are Ceylon, the Philippine Islands, the Malay Archipelago, Madras, Malabar, Coromandel, the Maldive and Nicobar Islands, Mauritius, the Seychelles, and the African coasts, as well as most of the tropical Pacific Islands. Most of the cocoanuts sold in Canada and the United States come from the West Indies. Jamaica and Trinidad are the principal exporters. The cocoanut is always shipped minus the outer husk. This is removed by striking the nut sharply on an iron-pointed stake firmly set in the ground. The fibre is then torn off by hand. The uses of this fibre have already been considered in Section 130.

151. Copra is the dried white flesh of the nut. In order to obtain copra the nuts are split in two with a hatchet. They are then left to dry a little in the sun. The copra is thus loosened and is easily lifted out of the shell. It is next dried either in the sun or in drying houses by artificially heated air. Copra is an important article of the world's commerce and the increasing use of oils and fats in industries is yearly increasing the demand. Among the South Sea Islands copra is the staple money crop. This South Sea harvest is collected by small trading schooners, putting out from Sydney. These scour the Pacific from Christmas Island on the east to the Solomon Islands on the west. The price paid to the natives is one hundred dollars per ton for copra. This is usually taken out in trade goods, these collecting schooners being floating department stores. It is said that the Sydney (Australia) branch of one of the British Soap Companies crushes a million and a half cocoanuts every week. This stupendous amount of copra is almost entirely gathered by the schooners mentioned above.

Copra and coir are also staple exports of all the producing countries just mentioned, excepting Jamaica and Trinidad. These islands, owing to their nearness to American and European markets, and the specialized fruit-carrying steamship lines which serve them, ship their cocoanuts in the fresh state.

152. Cocoanut Oil is obtained by breaking up the copra and grinding it to a meal. This is heated and subjected to

hydraulic pressure. The oil which oozes out is white in color, and in temperate regions is a solid at ordinary temperatures. After refining, it is one of our most valuable oils. It is used for many purposes, but principally for soap-making, margarine and candles. In India and the neighboring islands it is used as a fuel for cooking. The meal, after coming from the presses, is sold under the name of "poonac." It is used for feeding cattle.

Liverpool, Marseilles, Hamburg, Philadelphia and Boston are the chief industrial centres of the Western nations for cocoanut oil.

153. Linseed is the seed of the common flax plant so well known on these prairies. It is the source of what is, perhaps, the most important oil of commerce.

To obtain this oil, the flax seeds are crushed, placed in bags of canvas and subjected to heavy hydraulic pressure. The oil thus obtained is known as "cold drawn" linseed oil. After this process the meal is heated and subjected to further pressure when "hot pressed" oil is obtained. This is of an inferior quality. The meal remaining is sold as oil cake and used as a cattle-fattening food.

Linseed is what is known as a "vegetable drying oil," since it comes from a vegetable, and, upon exposure to the air, forms a hard varnish-like substance. It is the splendid weathering properties of this dried substance which makes it so valuable. It is used in the manufacture of paints and varnishes. It is the basis of printers' ink. Linoleum is made from it by mixing it with ground cork and gums. The oil can be vulcanized with sulphur to produce a substance similar to rubber.

"Boiled oil" is linseed oil boiled and mixed with certain substances, like litharge, lead acetate and manganese peroxide. These are technically termed "driers" since they cause the oil to dry more quickly. The United States uses up practically all the linseed oil produced in that country. It is principally used in the paint manufactories of Philadelphia and other Eastern American cities.

The bulk of the flax seed exported for oil pressing comes from the Argentine, India, Canada, the Netherlands and China.

Linseed oil is often adulterated with the cheaper and less useful cotton seed oil.

154. Cotton Seed. The production of cotton seed has been noted in Section 124. The United States is, of course, the chief source of supply. It is produced also in Egypt and India, and shipped to the European markets.

155. Rape Seed. This is the seed of a cabbage-like plant used as stock food or as a fertilized crop. The seeds when pressed yield a valuable oil called rape seed oil. India, China, Russia and the Argentine provide the seeds, which are crushed and pressed at all the great oil centres.

156. Sesame Seed. This is seed obtained from a low-growing annual grown in India, Egypt, Kenya Colony, Uganda and West Africa. The seeds are valuable for their oil which is used in soap-making. India and Egypt are the chief exporters. With the ever-increasing demand for oils, this plant is assuming greater importance every year.

157. Essential Oils. These are in general the volatile oils of plants which must be extracted from seeds, flowers, twigs, bark or stems, as the case may be, by the use of solvents and distillation or by distillation alone. Some are obtained by pressing the rinds of fruits, e.g., oranges and lemons. They are usually used for perfumery and flavoring purposes.

Orange, lemon and bergamot oils are chiefly obtained from Sicily and Calabria. Lime oil is produced in Montserrat. China sends anise and cassia oil to Hong Kong and thence all over the world. Her exports total over one million pounds in weight annually.

Attar of roses is an essential oil produced in Bulgaria and Northern Turkey. This is extremely expensive, since the rose-grower gets from three to five cents per pound for the roses, and it takes from 150 to 250 pounds of roses to distill one ounce of the perfume.

Grasse, in the South of France, is the leading centre of the world for essential oils used in perfumery. Many essential oils have important medicinal values. A delightful essay on the flower industry of Grasse is that written by Maeterlinck in *Life and Flowers.*

Camphor is a solid volatile oil obtained by distilling wood chipped from the camphor tree. The main source of supply is Tai-wan. It is used to a large extent in making celluloid and smokeless powders.

158. Gums and Resins. These are products, all of which are derived from exudations of plants. The exudations may be caused by mutilating the plant artificially, or they may be caused by insects. Sometimes they are caused by alteration of the plant tissues.

Gums are distinguished from resins in that they are soluble in water while resins are insoluble and must be dissolved in alcohol, or some similar solvent. Several resins occur as fossils. Amber and Kauri are examples.

159. Gums. Gum Arabic is obtained from small thorny trees of the Acacia species growing in Arabia, Egypt and the Sudan.

Gum Senegal is an inferior form obtained in th Senegal river region of West Africa.

These gums are the basis of most mucilages sold by stationers. Morocco gum, Barbary gum, Cape gum and Wattle gum are other varieties obtained from different species of Acacia trees growing in those countries.

Gum Tragacanth comes from low thorny shrubs growing in Asia Minor, Persia, Syria and Armenia.

Agar-Agar, sometimes called Bengal Isinglass, is a dried seaweed collected in China and Japan. It forms a jelly with water.

Iceland Moss yields a jelly which contains two gums, Lichenine and Isolichenine.

Irish Moss yields a soluble gum.

160. Resins. There are three forms of resins: True Resins, Gum Resins, and Oleo-Resins.

True Resins are compact masses, insoluble in water, and devoid of marked taste and smell. They are nearly all soluble in alcohol, ether, benzine, and most volatile oils. They may usually be saponified by treatment with caustic soda or caustic potash.

They are chiefly used in making varnish, soaps, sealing wax, medicine, and in sizing paper and cloth.

Common Resin or Colophony is a resin obtained from crude turpentine. It is largely used for making a lubricant called "rosin grease," and as an adulterant for olive and linseed oil. The principal sources of supply are the southern pine forests of the South-Eastern United States.

Burgundy Pitch is a resin resembling common rosin. It is obtained from the Norway spruce.

Mastic or Gum Mastic and Sandarac are resins obtained from evergreen shrubs growing around the Mediterranean shores. The Island of Chios and North Africa are the principal sources.

Amber is a fossil resin obtained along the German coast of the Baltic Sea. It is the hardest and heaviest of the resins. Transparent pieces are prized for jewelry, fancy articles, mouthpieces of pipes, and ornamental purposes. It is also used to prepare a fine transparent varnish much used in photography. When distilled it yields "Oil of Amber" and "Succinic Acid." These are used in medicine. The amber is thrown up along the coast of Prussia by storms, when it is gathered. Large deposits are found in some of the lakes of Courland (Baltic Sea). In some localities along the Baltic coast it is mined. Danzig is the great emporium for amber. It was greatly prized by the early Greeks, who maintained a trade route along the Bug and Vistula rivers in order to get it.

Copal is a resin obtained from the exudations of several varieties of trees native to the East Indies, the Philippines, South America and West Africa. Copal is taken direct from the

tree, but some varieties are found embedded in the soil. It is one of the most important resins used in varnish manufacture.

Dammar is a resin which exudes from the coniferous tree of the East Indies. It is used for light-colored transparent varnishes.

Dragon's Blood is a resinous substance obtained from the fruit of several small palms growing in Siam, the Moluccas and other East Indian islands. Its principal use is to color varnishes and to make stains imitating mahogany.

Guaiacum is a medicinal resin from the lignum vitae tree. It is produced in the West Indies.

Kauri Copal or Kauri Gum is a fossil resin somewhat like amber in appearance. It is the result of exudations from a native New Zealand tree. It is used extensively in varnish-making. Auckland is the principal centre for its export.

Mastic is a resin obtained from a tree in the Aegean Archipelago. It is used in making spirit varnish.

Shellac is a resin formed from plant sap by the females of the lac insect. Contrary to the usual impression the gum is not due to the bite of the insect. It is a secretion exuding from the body of the insect and is formed within the insect from the plant sap, somewhat in the same manner as beeswax is produced by the bee from the nectar of flowers.

The "lac" ultimately buries the insect and her eggs and forms a thick excrescence on the twigs. These twigs are broken off and enter commerce as "stick lac."

"Seed lac" is produced from stick lac by crushing, washing and drying. Seed lac consists of ruby red or orange-colored grains about the size of wheat grains. The color is due to a red dye produced by the lac insect. This was formerly extracted and sold as lac dye. It is now no longer an article of commerce, but before the introduction of aniline dyes large quantities of this dye were shipped to Europe. More than one and a half million pounds were shipped in 1880.

Shellac, or as it should really be written, "shell-lac," is prepared from the "seed lac." This is done by filling long narrow bags with dry seed lac to which has been added a mineral substance known as "orpiment." Sometimes rosin is used. The bag is heated over a fire until the seed lac melts and runs through the cloth. This is facilitated by twisting the bag. The seed lac is now flattened by stretching over a hot cylinder. It is now reheated and held between the feet and hands and pulled out into a thin sheet, which varies from light to dark orange in color. The sheet is broken up into small flakes and appears in commerce as "shellac."

"Button lac" is the highest priced grade of shellac. It is used for making sealing wax. Button lac is prepared from

superior kinds of stick lac in the same way as shellac, but instead of being pulled out into thin sheets and broken up, it is allowed to harden into round disks an inch to three inches in diameter.

Button lac is often adulterated up to 50% by rosin.

Shellac is used to make shellac varnishes, French varnishes, and lacquers. It is also used as a binder in making some composition goods, such as buttons, dominoes, poker chips, telephone receivers, and phonograph records. In the electrical industry it is a very useful insulator. "Cut" or dissolved in certain alkalies, it is used as a dressing on leather and patent leathers. Shoe-polish manufacturers use it. The paper manufacturer requires it to make surface-coated papers. The hat industry uses it to produce hard hats.

161. Oleo-resins are natural mixtures of the resin and the essential oils of the plant from which they exude. Among them is a group of substances which have a peculiar odor and pungent taste, and which are called "balsams." They are exudations from tropical trees. The most important are, Gum Benzoin, Peru Balsam, Tolu Balsam, and Styrax Balsam. They are chiefly used in medicine and perfumery, and for making incense.

Canada Balsam is an oleo-resin containing turpentine. It is a most valuable optical cement. It is not really a balsam.

162. Gum Resins are inspissated juices of plants containing both gums and resins. They form emulsions with water, due to the gum dissolving. Ammoniacum, Asafoetida, Euphorbina, Galbanum, Gamboge, Myrrh and Frankincense are the chief. They are used in medicine. Gamboge is also used as a paint pigment. Asafoetida is used in making Worcestershire sauce. Some of them, like Myrrh and Frankincense, are used in perfumery and incense.

163. Nuts.

Almonds—The almond tree is a native of Syria, Persia and Turkestan. There are two kinds of almonds, "bitter" and "sweet." The latter are the ones seen on festive occasions like Thanksgiving and Christmas. The bitter almonds are chiefly used to produce "almond oil." "Jordan almonds" are the finest table almonds. They are, however, usually grown in Spain and the name is now merely a trade term.

Spain, Morocco, Italy, Portugal and France are the leading exporters. Th almond tree is now being grown in the arid lands of Victoria and Queensland. Australian almonds are beginning to enter world markets.

Walnuts—The so-called English walnut is really of Persian origin. It is the most popular walnut on the market. It is grown extensively on the Pacific coast, especially in Southern California. There are two trees of this species native to America, viz.: the Black Walnut and the Butternut. Both these

trees grow in Eastern Canada and the Northern United States. Their nuts, however, have only a local importance in trade. The principal value of these trees lies in the excellent timber they produce, which is so highly prized for furniture-making. The walnut of commercial importance as a foodstuff is the English or Persian walnut. The chief sources of supply are the Mediterranean lands of Southern Europe and California.

Hazel Nuts are found everywhere in Eastern North America and North-Western Europe.

Barcelona Nuts are highly prized. They are chiefly exported from Spain.

Pecan Nuts come from the Gulf States of North America.

The Peanut, or ground nut, has already been treated. See Section 94.

Brazil Nuts are obtained from the forests of the Amazon and Orinoco river basins. They are familiar to everyone as "nigger-toes." The Brazil nut tree is one of the largest tropical trees. It is used as a shade tree in Brazilian cities. The nuts themselves are enclosed in a hard, round shell about as large as a grape fruit. The nigger-toes are packed inside this shell, generally about fifteen to twenty in a shell.

The crop is mainly gathered by native collectors, who bring the nuts down to the rivers, where they are bagged and sent overseas.

Hickory Nuts are a favorite American nut. There are several recognized species. Their range of growth is from Canada to Florida and Texas and as far west as Minnesota. They are not important commercially.

Chestnuts. The native chestnuts of this continent are not important commercially, although they are prized in local trade for their rich flavor. The foreign varieties are those chiefly used and the only ones that are grown commercially.

Native chestnuts are found in Canada and throughout all the Eastern United States.

The European Mediterranean countries are the chief source of chestnuts in foreign trade.

Animal Industries

164. Meat and Meat Supply. Meat is an expensive form of food, and this expensiveness shows little signs of diminishing. Still, in spite of its high cost, meat forms an essential part of the food of most modern nations. The meat bill of the world, however, does not seem large when compared with the huge sums that are paid for cereals.

The problem of increasing the meat supply to keep pace with the demand is one of the most exacting problems which modern commerce is called upon to solve.

Meat is not really an essential part of human diet. Millions of people rarely eat it, and many, because of religious belief, never eat it at all.

165. Relation of Meat Animals to Density of Population. Meat animals cannot be raised abundantly in regions which are densely populated. The reasons for this are simple. Meat animals require large areas of ground for pasture and for the raising of hay and other fodder crops in order to provide them with food.

In densely populated lands such areas are far too expensive to use for this purpose. The ground is required for other purposes, either industrial, or for the raising of food crops which will yield far larger returns per acre than the raising of animals.

Adequate proof of this is furnished by the following table:

Country—	Population per square mile	Cattle per square mile	Cattle per 1000 population
Argentina	7	26	4157
Australia	2	4	2950
Brazil	9	8	1190
Canada	3	3	1002
United States	35	16	653
France	195	69	372
British India	175	62	359
Germany	332	98	322
Great Britain and Ireland	386	99	264
European Russia	69	19	303

All figures are rounded off to the nearest whole number.

In the above table the first five countries are meat exporters.

British India, although appearing so low down in the list, has the largest cattle population in the world. The cattle, however, are principally draft animals. The small number of cattle to the square mile in Canada is due to climatic conditions in the North, to the large areas still under forests, and to the nature of the Canadian shield region. In Brazil it is due to the huge forested area. Australia's arid interior is the reason for the low density there; while in European Russia, climatic conditions and forested areas are important deterrent factors. The main reason in Russia, however, is that wheat, flax, rye, etc., are more profitable since the available acreage is so near centres of great population density.

Relation of Meat Animals to Hay Production—

The natural food of most of our meat-producing animals is grass. Therefore pastures are an essential feature of all farms which raise meat-producing animals. In order to carry cattle over the winter, dried grass is used in the form of hay. Hay is, therefore, a food supply crop for animals, and the animal is the machine which converts it into such readily saleable products as meat, butter, cheese, wool and hides. Animals also convert hay into energy which is utilized in the work of the farm or the transportation systems of towns and cities. In some parts of the world where the fall is rather dry, the grass lands are naturally converted into hay fields. This is one of the reasons why our own province of Alberta is such a fine stock-raising country.

In brief it may be said that wherever there is found a great hay production there will also be found a correspondingly great production of meat animals.

166. Cattle Distribution. The five important cattle-producing regions of the world are the north-west portion of Europe, India, North America, the La Plata countries of South America, and Australasia.

Of these India has the highest number of cattle, but they are largely draft animals, little use being made of their milk or meat. It will be seen by a little map study that these regions are widely separated. Meat is such a perishable product that important transportation problems have to be solved. It will also be noticed that the distribution of cattle is more general than some of the products previously studied.

Cattle can withstand a wide variation of heat and moisture. They do not do well, however, in very humid regions such as the humid plains of equatorial America or Africa. Cattle also are very strong and when raised on the ranges are very fleet. These qualities, combined with their large size, enable them either to meet a danger or escape from it.

The cattle industry of Canada is rather an adjunct of agriculture than a pastoral industry, except in Western Alberta, where ranching proper is carried on. The total value of cattle other than milch cows produced in Canada during 1923 was $316,473,000. In the United States, Texas is the principal cattle-raising state, Iowa and Wisconsin coming next.

In South America the Argentine and Uruguay are the leading producers. Paraguay and South-Eastern Brazil are also large contributors.

In Australia, Queensland and the northern territory of South Australia are the great ranching centres. New Zealand is a large meat exporter.

167. Effect of Modern Methods of Shipping and Preserving Meat upon the Beef Cattle Industry. Owing to the great improvements which have taken place in the preservation of meat, the quantity of this foodstuff which is carried around the world has now reached enormous proportions. This improvement plus rapid transportation has resulted in the dominance of the United States meat industry being successfully challenged by the Argentine Republic. It has also resulted in giving such remote lands as Australia and New Zealand access to the world's meat markets, and building up for them profitable industries. There are various methods adopted in the preservation of meats for transportation—

(1) Chilling and refrigerating.
(2) Smoking.
(3) Canning.
(4) Drying.
(5) Extracts.

(6) Cooking and then canning in the form of canned goods, soups, corned beef, etc., etc.

At the present time the greatest meat-exporting country in the world is the Argentine Republic. During the last fifteen years the refrigerating and packing industry in the Argentine has been developed enormously, and immense quantities of chilled carcases of beef and mutton are shipped to Great Britain and the United States from Buenos Aires and Rosario. Uruguay is also a great exporter. The principal centres are at Fray Bentos and Paysandu.

Australia and New Zealand also export great quantities of frozen beef and mutton carcases in special refrigerating ships. Canada as yet has not engaged to any great extent in this department of foreign trade.

168. The Dairying Industry. Commercially the dairy industry is almost entirely confined to the marketing of cows' milk and its products. It reaches its greatest importance in those lands having moderately cool climates and considerable rainfall.

These conditions result in a supply of green grasses and other necessary green stuffs to provide the type of food requisite to the production of milk on a large scale. Dairying cannot flourish as a commercial industry in arid lands. This is well shown by the sharp contrast of Northern Europe and those European countries having the Mediterranean type of climate. In Northern Europe dairying is one of the great industries, whilst around the Mediterranean it is, as a commercial enterprise, non-existent.

The dairying industry resolves itself naturally into three distinct divisions, viz.:

(1) The supplying of fresh milk and ice cream.
(2) Butter and cheese manufacturing.
(3) The condensing and drying of milk.

The branch of the industry carried on in any particular locality is largely determined by—

(1) Accessibility to markets.
(2) The amount of milk produced.
(3) The development of transportation facilities.

In Europe, excepting Switzerland, the dairying industry is usually confined to the first two divisions.

Great Britain, owing to the small area of the country, the excellence of her transportation methods and the large urban populations, consumes in the form of fresh milk about 70% of all the milk produced.

Denmark, Holland and Ireland convert their milk into butter and cheese.

Most of Great Britain's butter comes from Denmark and Ireland.

Holland is a great cheese-producing country.

The canning of butter and the shipping of it to tropical lands are important features of the Dutch butter industry.

Switzerland converts her large annual production of milk into cheese and milk chocolate. This is necessitated by the difficulties of transport in mountain regions rather than by distance from markets.

In Canada, Ontario and Quebec are the greatest centres of dairying. Here are situated more than 2,500 factories engaged in the making of cheese and butter. There are also in Canada 25 plants which manufacture condensed milk, evaporated milk, and milk powder.

Alberta has 84 engaged in butter and cheese factories and ranks the third province in Canada in the manufacture of both these products.

The total value of the dairy products produced in Canada during 1923 was estimated at $238,693,885. Of this total, $56,873,510 was the value of creamery butter, $28,645,192 of factory cheese, and $34,601,688 of miscellaneous dairy factory products. Dairy butter accounts for $32,000,000; ice cream $3,840,476; and whole milk, apart from that sold by dairy factories, produced more than 82½ million dollars. In the United States, New York and Wisconsin are the leading states.

The dairying industry in the Argentine is not as yet very well developed. Large amounts of Argentine butter, however, are shipped across to South Africa, where the herds have been seriously depleted by the ravages of rinderpest and several other cattle diseases, and by the upset due to the Boer War. Some Argentine dairy produce reaches Great Britain, but on the whole most of it is consumed in and around Buenos Aires.

Australia and New Zealand ship large amounts of butter and cheese to Great Britain, but the quality is inferior to that of the Danish and the Irish product, which control the market.

Transportation of Dairy Products—

Here modern methods of refrigeration and speedy transport by special milk trains and auto trucks have revolutionized the supply of fresh milk to the great city populations. These modern methods have also enabled farmers living at considerable distances from the city to enter into profitable dairy production. With a view to standardizing the product and preventing fraud, and also with a view to safeguarding the health of the consumer, most cities have adopted very rigid by-laws governing the sale, production and transport of milk within their areas.

Dairy Substitutes—

In very hot countries the difficulty of producing, transporting and distributing milk and butter leads to the use of such

edible vegetable fats as olive oil, soy bean oil, and cottonseed oil as a substitute for dairy products.

What are usually understood by dairy substitutes, are, however, certain products such as oleomargarine, renovated butter, peanut oil and cocoanut oil. These are all wholesome fats, and are chiefly used by people who cannot afford real butter. The chief objection to oleomargarine is that it is often fraudulently sold for real butter by dishonest dealers.

Oleomargarine is produced in packing plants from neutral lard, beef fat, and cottonseed oil. Milk is added to give flavor, and egg yolks are sometimes added to give color.

Peanut Oil and Peanut Butter. Peanut oil is obtained by expressing the oil from ground nuts. It is used for salad dressings and, in France, for packing the cheaper varieties of sardines. Peanut butter is obtained by grinding the peanuts and adding a little olive or cottonseed oil. It is very nutritious and has the merit of being cheap.

Cocoanut Oil is more like butter in its composition than any other vegetable oil. It is now largely used for biscuit-making, as an ingredient of oleomargarine, by bakers, and for various culinary purposes. The increasing cost of milk and butter is bringing these substitutes more and more into use for cooking purposes among the poorer classes.

169. Swine. The production of swine is affected more strongly by economic than by climatic conditions. The hog is an omnivorous feeder. This makes him a valuable animal for converting household waste, dairy waste, and surplus grain products into meat. The hog is especially valuable as a meat animal in China, where the density of the population prevents the rearing of cattle and other meat animals requiring large pasture range. The original home of the hog was the forest. Here he lived on roots, nuts, acorns, grubs and similar nutritious foods. (Note—See the description of swine husbandry among the Anglo-Saxons given by Sir Walter Scott in *Ivanhoe.*) The hog, therefore, has a small stomach, and cannot, like cattle and sheep, assimilate such bulky fodder as hay. Swine are, therefore, raised most abundantly near grain-growing districts and on the edges of forests. The hog is found practically all over the world. The South Sea Islands have a wild pig, which has descended from pigs turned loose on them by the early explorers of the Pacific. The comparatively small size of the hog, his tameness and great prolificacy, coupled with his early maturing powers, make him of great local importance as a source of meat supply both in crowded and in sparsely populated regions.

Relation of the Swine Industry to Grain-growing—

There are two main types of hogs: the lard hog and the bacon hog. The lard hog is characterized by its great ability to produce fat. This is the great American type. The reason for this is a geographic one. The great corn belt area of the

United States is, as we have previously seen, not suited for wheat production. Corn, however, grows well. This grain is rich in fat and so the lard hog is used to transform it into pork and fat.

The bacon hog, on the other hand, since it is not able to assimilate such fattening food as corn, is the product of those cooler regions more adapted to the cultivation of grains like wheat and oats which are essentially "protein builders." Hence the fundamental difference between the Canadian bacon hog and the United States lard hog. The bacon hog is raised in Denmark and Ireland also, and is used for the production of the famous Wiltshire side breakfast bacon, so loved by the Englishman.

Relation of the Swine Industry to the Forest—

In many European countries such as South-Western Germany and Serbia, the hog is raised on the forested slopes of mountains, where he feeds mainly upon beech nuts. In the United States, hogs are raised in the forests of the Appalachian Highlands, and on Ozark Plateau. These herds form the staple meat diet of many people in the Southern United States. Owing to their grubbing habits, however, the hogs do great damage to the valuable southern pine forests, which are almost the sole source of supply for many valuable resins and true turpentine.

Large quantities of bacon are exported from the United States, Canada and Denmark.

The great bacon-importing country is Great Britain. The enormous bacon imports of Great Britain are largely supplied by the Danes, who made a specialty of catering to the Britishers' preference for Wiltshire side bacon. Canada has since the war made great inroads into Denmark's virtual monopoly of the bacon trade with Britain. If Canadian farmers would realize more fully that the type of hog best suited to her geographic conditions is the bacon type, the trade in bacon with Britain could be greatly increased. As the matter stands at present Denmark is likely to regain lost ground, because the Danes study the market, and produce what the customer requires.

The Eastern Canadian farmer is rapidly adjusting his product, but the Western farmer, who is recruited so largely from the United States, still clings to his lard hog types, and attempts the impossible task of making bacon with wheat or oats from a corn type of hog.

170. Sheep. Originally sheep were native to the rough uplands and dry plateau regions. Their wild relatives are now found in the most inaccessible mountains. Even after long domestication, sheep are very prone to foot rot and parasitic diseases when bred on moist lowlands.

Sheep are raised for their wool and flesh. Some countries, as, for example, certain Mediterranean lands, raise them as

milch animals. The raising of sheep for wool is an extensive industry, but is gradually disappearing from regions of dense populations. In Great Britain, however, the sheep-raising industry, based on the dual purpose of wool and mutton production, is thriving.

The most famous breeds of sheep, with the exception of the Merino, are of British origin, and are kept up to standard in other parts of the world by frequent introduction of British rams and ewes. There are six great world centres of sheep-raising. These great centres are Great Britain, Italy and the Balkan Peninsula; Argentina, Uruguay, and Falkland Islands; South Africa; Australia; and New Zealand. It will be seen that four of these regions are located in the Southern Hemisphere where the lands are new and the populations sparse. Other important sheep-raising countries are the United States, Russia and Hungary. The sheep is an especially valuable animal in regions remote from centres of civilization. The reasons for this are:

(1) Wool is one of the great unfulfilled requirements of civilization.

(2) Wool is not a perishable commodity.

(3) Sheep are easily raised and are very hardy.

Central Asia and the Falkland Islands are splendid illustrations of remote lands which can profitably engage in sheep-raising.

The introduction of refrigeration and rapid transport have had very far-reaching effects on the production of sheep.

The Argentine, Australian and New Zealand sheep-raising industries would be in a sad state without these valuable aids. Australia is the leading sheep-raising country in the world, and is followed closely by Argentina.

Australia is the leading wool exporter, Argentina second, and South Africa third. New Zealand is the leading mutton exporter, Argentina second, and Australia third.

171. Goats. The goat is primarily an animal of the semi-arid regions. With the exception of the Angora variety, goats are of no value as fibre producers. They are, therefore, produced for their flesh, skins and milk.

India raises the largest number of goats, but they are of small importance locally and have no value in export trade.

Asia Minor and South Africa—

Asia Minor is the home of the Angora goat. This goat was carried to South Africa, which now produces a far larger amount of mohair, as the wool of this goat is called, than Asia Minor. The Asian mohair is, however, of finer quality than the South African variety. Mohair is a valuable textile fibre and owes its

importance to the enterprise of Sir Titus Salt, the Yorkshire manufacturer of plushes and velvets. Prior to his success in using this commodity, mohair had little value.

The United States, Mexico and Argentina all raise goats on their arid and semi-arid lands. Goat mutton, especially the Angora type, is a very fine meat food. Goat milk and cheese are staple food products in Mediterranean lands. The hides are used for gloves and other fine leather products.

172. Draft Animals. The uses of the horse, mule, donkey, etc., are too well known to require any elaboration here.

The only animal which can be used in crossing the highest passes of the Himalaya mountains is the yak. In the Andes, the llama is used. This is an animal very like a sheep but with a long neck. It is often called the "American camel."

The llama stands about 3 feet high at the shoulder and carries a load of 100 lbs. It is the most commonly used pack animal on the Pacific slopes of the Andes.

Llamas are, however, being displaced in many of the lower parts of the Andes by the mule and the railroad.

In the days when Potosi was the greatest silver-mining camp in the world it is said that 3,000,000 of these little animals were engaged in transporting the silver bars from these mines alone.

In disposition the llama is much like the camel. It will insist on going at its own speed, and will frequently sulk and lie down if it considers its load is too heavy. Rather a remarkable characteristic of llamas is that of spitting in the face of persons with whom they become annoyed. If a man is riding one of the animals and it feels tired, it turns its head around and discharges a mouthful of offensive saliva into the rider's face.

In India, south of the Himalayas, and in the Malay Peninsula, the elephant is very much used. The elephant requires a large amount of food but he is so big and strong that he can carry very big loads. The elephant is also very intelligent. His great strength and intelligence make up for his enormous appetite.

In Northern British Columbia, where the forest growth is dense and the trail often blocked with fallen timber, the dog is used as a pack animal. The reason for using it is that it can pass anywhere a man can get through. Also, if the trail is blocked with fallen timber it can scramble under, while if a pack horse were used, it would be necessary to chop out a trail wide enough for the horse and its pack to pass. A pack dog about the size of a collie dog will carry about 40 pounds weight. The most favored dog for this work is the Airedale. Dogs broken to the pack sell from $35 to $75. In the great hot deserts of Africa and Asia the only animal which can be used for transport is the camel. When the Australian Government built

the telegraph line across the Great Australian Desert, camels were imported to carry the supplies. Now camel trains are a feature of the Australian desert transport.

The camel is called "the ship of the desert." Upon it the commerce of the hot, sandy, rainless deserts of the Old World depends. It is an awkward, ungainly-looking animal. Great humps, loose joints, sprawling legs, big feet, wizened-looking face, and a long neck, all join to produce an animal that for pure ugliness is hard to beat. Add to this a disposition for which no equal can be found for sheer cussedness on the face of the earth and you have the camel.

A common mistake about camels is that the single-humped camel is a "dromedary." This is quite wrong. The single-humped camel is the Arabian camel and the two-humped camel the Bactrian camel. There are many different breeds of the Arabian camels, just as there are different breeds of horses. But just as in the case of horses we divide them into saddle and draught horses, so the Arab divides camels into two classes, riding and baggage camels. The fast riding camels are called dromedaries. A good dromedary will carry a man and his baggage seventy or eighty miles a day and keep it up for several days in succession.

The camel is to the Arab what the reindeer is to the Lapp and the Eskimo. Not only does he use it as a beast of burden, but he lives on the rich thick milk, which he mixes with meal. The tents in which he lives, and the burnous or great mantle which he wears, are made of camel's hair. The hair is clipped from the animal each year. From its skin he makes tents, shields, harness, saddles, trunks, and many other articles.

In order to make desert travel as safe as possible, the merchants gather together at some point. Here the various small groups unite and form a long procession under the leadership of a guide. In the Sahara this guide is usually an Arab, but in other places he is generally a native of the country.

The great dangers of desert travel are the wandering bands of robbers, the sand storms, and the chance of missing the water holes or oases. The mirage with its deceitful imitation of oases is also a source of danger to travellers in the desert.

There is, however, another sort of desert. This is the frozen desert. Large portions of the earth in the Northern Hemisphere are just as truly desert as the barren areas in Africa, Asia and Australia. Like the hot desert, these places support some people. In our own Dominion of Canada, on the shores of the Arctic Ocean, there is such a cold desert. The chief inhabitants are the Eskimos. In Europe and Asia there are similar regions. They are inhabited by people called Lapps and Samoyedes.

The principal means of transportation in these northern regions is by dog or reindeer sledge in winter and the boat or pack reindeer in summer. The dog is the animal most favored

by the Eskimo and Samoyede, while the Lapp prefers the reindeer. Among the Lapps the reindeer represents wealth. Some of the Laplanders own large herds of a thousand or more of these animals. The food of the reindeer is moss and sea weed. This makes it a valuable animal for man's use in the frozen deserts, for he cannot grow hay or oats in such cold places.

In North America there are great bands of caribou, which is the American reindeer, but the Eskimos and Indians have not tamed the caribou as the Lapps have done. This is a pity, because our northern lands are thus deprived of a valuable animal for transport. In summer the Lapp uses the reindeer like a pack horse, but in winter he harnesses the animal to a sledge. Reindeer are pretty fast travellers and are much less trouble to manage than are dogs. They are also much more valuable than dogs because their milk and flesh can be used for food. From their hides are made clothing and robes, while their sinews provide sewing thread, and their bones furnish all sorts of implements such as knives, needles, fish hooks, harpoons, and many other things.

173. Poultry and Small Animal Industries. Mr. F. C. Elford, Dominion Poultry Husbandman, says: "There are few conditions under which hens cannot thrive. Poultry can be reared in any climate, and almost under any condition. Probably no class of live stock is so widely scattered and universally reared. From the warmest regions of the tropics to the cold, bleak regions of the North, man demands eggs as one of the staple articles necessary to sustain life. In eggs the first quality is preferred; therefore, the hen has been taken along, and we find poultry adapted and acclimatized to all regions inhabited by civilized man. There is no country so hot or so cold but that some varieties thrive. Dry weather or wet weather will not kill the poultry crop, and neither the early frost nor the late frost leaves us without a reasonable return. In fact, in every known region where human beings exist there is a place for poultry."

Quotation from Bulletin 89, Poultry Division, Department of Agriculture, Dominion of Canada: "The importance of the poultry and egg industry is often overlooked by statisticians and economists. This, no doubt, results from the fact that the poultry industry is a non-capitalistic industry. Yet the aggregate value of the industry is enormous. In Canada, in 1922, the industry accounted for 4.1% of the total revenue from agriculture, being the fourth most important agricultural industry in the Dominion. In value of exports from the Dominion, eggs were responsible for a total of $1,027,171 in 1924. But these figures pale into insignificance beside the aggregate from poultry and eggs in the United States. In that country the production of eggs and chickens was estimated at $1,047,989,919 for the year 1919. This is approximately half the value of the wheat crop of the United States for that year. The United States is

the greatest producer of iron and steel in the world, yet the value of the iron and steel produced is far less than the egg and poultry production.''

These figures are far less than the aggregates for China and Europe.

The varieties of market poultry include chickens, pullets, fowls and capons, turkeys, ducks, geese and guinea fowl. These stupendous figures are the results of three main types of poultry—

(1) The backyard poultry.
(2) The farmyard poultry.
(3) The poultry farm.

Of these, by far the most important is the farmyard class. Farmyard poultry is a by-product of the extensive type of agriculture, whilst the poultry farm is a typical intensive type.

The greatest commerce in eggs is carried on in Europe. The density of the population and the relatively short hauls make trade in fresh eggs possible.

Great Britain is the greatest egg-importing country in the world. It is stated that her egg imports total nearly 200 million dozen annually. The greater portion of these come from France, Belgium, Germany and Denmark. In Germany the goose is one of the main products of the poultry industry. The geese are pastured in flocks, since they feed largely by grazing.

In Ontario the turkey is an important poultry product. The greater portion of the Christmas turkeys sold in the London stores are the product of the Ontario farms.

An interesting item in the Dominion Poultry Statistics for 1914 was the import of $59,954 worth of eggs from China into Canada. In Tsingtao, China, there are several factories engaged in converting millions of eggs into dried eggs, dried egg yolk and albumen. In this form eggs are said to keep indefinitely and are very easily transported.

174. Ostrich Farming. The true home of the ostrich is Africa. Ostriches have, however, been introduced into California, Argentina and Australia. The Union of South Africa is, however, still the leading producer. The rearing of ostriches has been developed to a high pitch of efficiency by the British settlers in South Africa. The birds are registered and have been improved by judicious selection. The pure bred registered South African birds command very high prices. Five thousand dollars for a registered cock is not an uncommon price. The industry is mainly centred around Port Elizabeth. The much-prized ostrich feathers are the chief product. The price for feathers is about two hundred dollars per pound, and the value of the feather exports of the Union of South Africa is approximately nine millions of dollars annually. This comes from about

half a million birds. In order to protect the industry, the Union Government enacts very strict laws, absolutely prohibiting the exporting of the eggs. The industry is largely dependent upon the caprice of fashion, and the Afrikanders are keenly alive to the importance of maintaining the interest of the directors of fashion.

175. Bee-keeping. The keeping of bees is a very scientific type of animal industry. It is dependent upon dense populations for its highest commercial development. It is also very dependent upon a vegetable environment. Nectar-bearing flowers must be abundant where bees are kept. Those tropical lands having abundant moisture are the most important bee lands. The products of the industry are wax and honey. The Roman Catholic countries are great consumers of beeswax, since the wax is used for their altar candles.

Honey and beeswax are important exports from some of the West Indian islands.

In Canada and the United States bee-keeping is a by-product of the farming industry. Ontario is Canada's leading producer.

176. Rearing of Song-Birds. The trade in these feathered pets is much greater than would be supposed. The principal song-bird is the canary. This bird was originally a native of the Canary Islands. For over four hundred years it has been domesticated and modified into several distinct breeds, such as the Hartz Mountain Canary, the Norwich Croppy, the Yorkshire Canary, etc. The principal centres of the industry are the industrial regions of the Hartz Mountains in Germany, the textile districts of Lancashire, Yorkshire and Norfolk.

The birds are largely bred by the workers, since the breeding can be carried on in their homes at little expense. The industry enables these people to supplement their income very materially. The German birds are the favorites on this continent. These birds are very imitative in their song and are taught a few notes and trills by the musically-inclined German workers. In Great Britain the local birds are greatly prized and preferred to the German varieties.

The imports into the United States are said to amount to 600,000 birds annually. There are no authentic figures for Canada.

177. The Raising of Rabbits. The rabbit industry attains quite respectable proportions, especially among the small farmers of France and Belgium. They are easy to care for and their fecundity is high. They thrive in close confinement. They feed on a very wide range of vegetable food. Great Britain imports about five million dollars' worth annually. Large numbers of these, of course, come in the refrigerating ships from Australia, where, as everyone knows, rabbits are a fearful pest.

The Belgian and French farmers raise immense numbers for fur. Many of the modern handsome furs are simply the fur of the Belgian Hare (which is not really a hare but a large rabbit), dyed and treated. The electric seal coats are rabbit skins, shaved and dyed to imitate sealskin.

178. Fisheries. Fish are obtained from the rivers, lakes and seas in great quantities, but by far the largest quantity comes from the sea. All the coastal peoples from the Eskimo in the far north to the Patagonian at the southernmost tip of the New World engage in fishing. Notwithstanding this widespread distribution in fishing, however, the great commercial fisheries are all located in the North Temperate Zone.

The relative importance of fishing, as an industrial enterprise, is not as great as is often imagined. There are several reasons for this. The principal are:

(1) The hazardous nature of the pursuit.
(2) The distance of the fishing grounds from the homes of the people.
(3) The unreliability of the yield.
(4) The perishable nature of the product.
(5) The difficulties of transportation.

The fisheries of the world are divided into two great classes:

(1) Ocean fisheries.
(2) Inland fisheries.

The ocean fisheries are again divided into "Deep Sea fisheries" and "Inshore fisheries."

The location of the world's fisheries is influenced mainly by two factors—

(1) The spawning habits of the different species.
(2) The food habits.

Most fish either spawn (that is, lay their eggs) in shallow coastal waters, or else ascend rivers for the purpose. Very few edible fish spawn in the deeper waters of the ocean.

Food Habits—Fish feed either on other fish and minute organisms, or on the growth of sea weeds and sea grasses which fringe the sea coasts. Ultimately all life in the sea depends directly or indirectly upon vegetable matter. Vegetable matter must have sunlight in order to photo-synthesize the carbon dioxide into food. The rays of the sun cannot penetrate the deeper abysses of the ocean. Consequently the shallow waters over the continental shelves and off shore banks are the only places where this type of vegetation flourishes. The vegetable-feeding fishes, therefore, crowd around these vegetated parts of the seas in search of food. The carnivorous species follow them in order to feed on them in turn.

These sea-meadows are also safe places for spawning and the rearing of young fishes. The result of these two factors, then, is the crowding of fish into the shallower waters over the great continental shelves.

Study a map of the world showing the ocean depths and see how the world's great fisheries are concentrated in the shallower seas. The continental shelves of North-Western Europe, Eastern North America, Pacific North America, the southern tip of South America, the Agulhas Banks of South Africa and the shelves of Eastern Asia and Australia are all great fishing grounds.

The Three Important Fishing Grounds—

The fishing grounds of the Southern Hemisphere are all located where populations are sparse ,and whence the transportation haul is too great for the fish to be brought to the markets of the dense populations of the Northern Hemisphere. As a result these southern fishing grounds have only a local importance.

The Agulhas Banks supply the South African coast towns and Johannesburg with an abundance of fresh fish, mainly sole and a pink-fleshed fish known as Cape Salmon. The Australian coastal shelf at the south-east corner of that continent supplies Melbourne and Sydney and the inland towns of Victoria and New South Wales. The principal food fish is the "Barracouta." All through the East Indian Archipelago fish is an important food. The species used for food are brilliantly colored and appear strange to us. The Chinese are great fishermen. Owing to the crowded condition of their land there is little room to produce large animals for food. This forces the Chinese to use fish as a source of protein in their diet. The Sea of Japan is an important fishing ground. The fisheries here, however, do little more than supply the needs of the people of China and Japan. Commercially they are of little significance.

The three chief commercial fishing grounds are—

(1) The North Sea Fisheries.
(2) The Banks of Newfoundland and the Gulf of St. Lawrence.
(3) The North Pacific Coast of North America.

The principal products of the North Sea fisheries are Herring, Mackerel, Pilchard, Cod. Sole, Plaice, Whiting, Turbot, Haddock, Hake and Halibut. In addition, crustaceans such as Crabs, Lobsters, Prawns, Shrimps and Crayfish are produced in great numbers. Shell fish like Mussels, Cockles, Oysters and Periwinkles are also produced.

The Newfoundland and St. Lawrence fishing grounds yield Cod, Haddock, Hake, Halibut, Alewives and Menhadden. Along the coasts of Maine and New Brunswick is found the "American Sardine," which is not really a sardine, but a small herring. Oysters are very abundant here, and are large and succulent. Crabs, Lobsters, Crayfish and Prawns are the principal crusta-

ceans. Mussels and Clams are, with Oysters, the principal shell fish. The Pacific Coast fishing grounds yield principally Salmon and Halibut.

Other important Pacific Coast fish are Herring, Mackerel and Cod.

Methods of Fishing—Steam trawlers and steam drifters are the principal devices used in the North Sea fisheries. The otter-trawl is used for cod, haddock, plaice and other bottom fish. The drifter is used to catch the herring and mackerel. The steam trawler is virtually a huge tank into which the catch is emptied and kept alive until port is reached. The vessel is thus enabled to remain at sea for several days. The herring fishery of the North Sea is interesting. These fish appear in shoals off Stornoway about April and move around the coast until Yarmouth is reached in September. Every available vessel between these two points is pressed into service. The Scottish fishermen are accompanied by thousands of Scotch fish-wives who work in and about Yarmouth gutting the herrings for packing, or splitting them for kippering. Fifty million herrings for a day's catch along the coast is common. Grimsby, the Lincolnshire port on the Humber, is the greatest fishing town in the world. Yarmouth is the greatest centre of the herring industry. The herring catch is shipped to Billingsgate fish market in London, the great provincial manufacturing towns, and the French, Dutch, Belgian, and German ports.

The Newfoundland and Gulf of St. Lawrence Methods—The most important fish caught in these waters is the cod. This fish feeds along the bottom. It is commonly caught on a "trawl." This consists of a long line often 3,000 feet long. Attached to this line at short intervals are shorter lines bearing hooks. The long lines are stretched between schooners. Men in "dories" attend to the business of lifting the lines, taking fish off the hooks, and re-baiting them.

The fact that the Great Banks, as this area is called, lie right in the path of the great steamship lines, together with the fogginess of the atmosphere, makes the work of these dorymen very dangerous. Icebergs are common, and storms violent and very prevalent. Also the fishing vessels are in danger of being run down by the passing steamers. All this results in many accidents and a large loss of life every year.

Halibut and hake, being bottom fish, are also caught by the cod fishermen.

Mackerel and herring are caught with gill nets and drifters. They are the main product of the inshore fisheries. They are seldom fished more than about 15 miles from the shore. The motor boat is principally used for this type of fishing and the men go out every morning and return in the afternoon with the day's catch. The deep sea men remain at sea several days until they have a boat load. This means that the cod, halibut

and hake must be cleaned and salted each day. When the vessels return, the catch is spread out to dry in the sun. It is then smoked, packed and shipped. The bulk of the overseas trade goes to Great Britain. The otter trawl operated by steamers is now being used to a considerable extent in these waters.

The Pacific Coast Methods—

The salmon is the predominating fish in these waters. It is caught by hooks and lines, spring nets, and fish wheels. The halibut is caught from dories by line trawls.

The salmon and halibut are shipped fresh from Prince Rupert by special fish trains over the Canadian National Railways. The greater part of the salmon catch, however, is canned and shipped to all parts of the world. Salmon-canning is Canada's greatest fishing industry.

179. Shore and River Fisheries. Rivers and bays often are productive fishing grounds. This is usually due to the fish crowding into these sheltered places to spawn. The principal products of these fisheries are salmon, sturgeon, oysters, lobsters, clams, sponges and pearls.

The salmon return to the rivers every four years in order to spawn. After spawning they die. They are caught in immense numbers during this migration. The Columbia, Fraser, Deane, Bella Coola, Skeena, Stikine, and Yukon rivers of the Pacific Coast are the chief rivers commercially fished for salmon. Around their mouths are located the many salmon canning factories of the Pacific Coast.

The sturgeon swarms up the Volga from the Caspian Sea in immense numbers every year. It is the largest fish caught in rivers. The Russians catch sturgeon for their eggs, which are sold as "caviar." Years ago they swarmed up the American rivers but they have been practically "fished out" and the industry has disappeared from this continent.

Oysters live on the sandy and gravelly bottoms of shallow bays and estuaries. The greatest oyster beds are found around Baltimore. They are very plentiful from the Gulf of St. Lawrence to Galveston. The Canadian "Maalpec" oyster from Prince Edward Island is greatly esteemed. Oysters are also fairly abundant around the British coast. The Romans considered the British oyster the most delicious of foods. As the natural supply of oysters did not prove equal to the demand, they are now largely produced by a method of culture. Oyster culture is carried out by planting the small oysters in beds and allowing them to grow. Another method is to put down beds of old oyster shells and bushy tops of trees on the bottoms of sheltered bays. These bushy tops provide an anchorage for the spawn which is floating about. The spawn attaches itself to them and forms a new oyster bed.

Clams are shellfish of the oyster variety, but they are able by means of a protruding "foot" to crawl about, whereas the oyster remains fixed. They are one of the most valuable of American molluscs.

Lobsters are a kind of crayfish. They are caught in baited box traps called lobster pots. They are extensively caught and canned, or sold boiled. Most of the present world's supply of canned lobster comes from Canada and Newfoundland.

Sponges are the skeletal parts of small animals which live in colonies or groups. The fleshy part is rotted and washed away prior to shipment. Sponges can only flourish in warm waters. The finest sponges come from the Mediterranean Sea. They are also obtained from the West Indies. Sponges are collected by divers. They are now being cultured, the method of culture being to tie a piece of living sponge to a stone and to place it on the sea floor in a favorable spot.

Pearls are nacreous concretions found in the shells of certain oysters. These oysters are not edible. The shells are collected by divers and opened by allowing them to rot in the sun. The opened shells are then searched for the pearls. The finest pearls come from the Persian Gulf. There are important pearl fisheries in Ceylon, the coast of Venezuela, and the Gulf of California. The Japanese have found a method of inducing the secretion of pearls by irritating the oyster. In recent years the pearl has been so well imitated that it requires an expert to distinguish the natural from the artificial pearl. The pearl industry is precarious, and the yield small for the amount of shells collected. Besides the pearl itself, the pearl-like covering of the inside of certain shells is a valuable article of commerce. It is used for making knife handles, buttons, and for inlaying. It is known as "mother of pearl." Its production is important along the Australian coasts and as a by-product of all pearl fisheries.

180. Inland Fisheries. These are of small importance compared with ocean fisheries. The greatest inland fisheries having commercial importance are those of North America. Canada contains in her lakes and rivers about half of the fresh water of the world. Much of this vast amount of water, however, is so far from transportation and markets as to be as yet unimportant as a source of fresh-water fish. The most extensive inland fisheries are concentrated around the Great Lakes region. These fisheries employ steam tubs, gasoline-boats, sail-boats, and row-boats. The fishing is carried on by means of gill nets and stationary pound nets. The chief products are trout, herring, whitefish, pickerel, pike and perch. The greater part of the catch of the Great Lakes is marketed in the United States. In Western Canada, the lakes and rivers of the Prairie Provinces yield an abundance of fish. The difficulties of transportation greatly hamper the industry. Such lakes as the Great Slave and Great Bear have immense quantities of fine fish, but they are too far from markets to be developed as yet.

181. Fish Canneries. The canning of fish is an important branch of the fishing industry. The perishable nature of fish precludes its shipment over any great distances unless dried or canned. The dried fish is also subject to deterioration unless carefully packed and stored. Canning, therefore, remains the only safe method of preparing fish for export to distant parts. Fish-canning is one of Canada's leading industries. During 1921 there were in operation in the Dominion 538 establishments canning lobsters, 228 fish-curing establishments, 58 salmon canneries, 5 sardine canneries, and 8 clam canneries. The salmon canneries are confined to the Pacific Coast.

182. Canada's Fishing Industry. Canada possesses, perhaps, the most extensive fishing areas of the world. The produce of these great areas is a national asset of the first order. True, it does not rival the products of the farm, forest or mine, but it does bulk large in our national economy.

Canada's geographic position with regard to fishing grounds is not well realized by most Canadians. Two of the world's four greatest fishing grounds border her coasts. In addition, her fresh-water lakes constitute half the fresh-water area of the world. These fresh-water areas teem with valuable fish. Besides this, the great inland sea of Hudson Bay remains practically untouched. These last two sources provide a reserve which must ultimately be a source of great revenue to Canadians. Canada ranks third among the fishing nations of the world, being only surpassed by Great Britain and the United States.

Of the three great salt-water fishing areas in the world—North Atlantic, North Pacific, and North Sea—Canada controls one-half of the two first. Sea fish include salmon, cod, lobster, halibut, herring, mackerel, haddock.

Production—1923: $42,565,545. British Columbia came first, 1923, $20,795,914; Nova Scotia, $8,448,385; New Brunswick, $4,548,535; Prince Edward Island, $1,754,980; Quebec, $2,100,412; Ontario, $3,159,427; Prairie Provinces and Yukon, $1,757,892.

Kinds—Salmon led in value, $12,534,515; lobsters, $6,365,-362; cod, $4,079,397; halibut, $6,596,452; herring, $2,659,804; mackerel, $617,978; whitefish, $1,629,143; haddock, $1,046,808; smelts, $868,629; trout, $823,767; pickerel, $909,471; sardines, $1,016,810.

Industry—Employees, 68,964, viz.: 53,517 in primary operations and 15,447 in fish canning and curing establishments. Capital $23,645,316 in primary operations, and $24,027,549 in fish canning and curing. Total of $47,672,865.

183. Sealing and Whaling. Although neither seals nor whales are fish, their pursuit is colloquially termed "fishing."

The seal is a mammal which lives in the sea, and obtains from it all its food. It must, however, come to shore in order to breed. These two facts have resulted in the animal being hunted both by sea and by land. The result is that seal-hunting is not the profitable undertaking it once was. Sealing is now closely supervised by governments. This is necessary to prevent the complete extermination of this valuable animal. Today the chief centre of fur seal-fishing is the Pribylov islands in the Behring Sea. These islands belong to the United States. Other islands in the Behring Sea and the beaches of the mainland of Arctic Canada and Siberia are also important haunts of the seal for breeding purposes.

In 1911, in order to protect the industry, a treaty was signed by the United States, Canada and Japan, who all agreed to stop open sea hunting of the seal, and to take only the young males of from two to four years old when on shore for breeding purposes, and these only under the strictest regulations. This is having the effect of at least delaying the extermination of this beautiful and valuable animal. The skins are mostly sold in London. There are several varieties of seal, but only the fur seal is valuable as a fur-bearing animal.

Whaling is, of all "fishing" ventures, the one which most typically belongs to the open ocean. Whaling ships traverse immense distances and are often long periods away from their home ports. It is now a declining industry. The world's demand for oil has nearly exterminated this gigantic mammal of the seas. Whaling is still carried on in the Arctic Ocean near Behring Straits and in the Antarctic Ocean and Southern Atlantic, the chief southern centres being the Island of South Georgia, and Cape Town. The whale which yields the valuable spermaceti wax is a southern species. The northern whale yields only train oil and whalebone. Whalebone is not the bone of the whale, but a horny substance which is taken from the roof of the mouth. Ambergris is a substance secreted in the intestines of the whale and found floating on the seas. It has a pleasant perfume and is very valuable. It is used in perfumery.

San Francisco is now the principal centre for whaling operations in the United States.

Kyuoquot, on the West Coast of Vancouver Island, and Naden Harbor, in Queen Charlotte Islands, are the principal Canadian whaling stations.

184. Fundamentals of Manufacture. By the term manufacturing we mean the process of transforming the raw products of nature into articles suited for the use of mankind.

It is sometimes called "secondary production," since it takes the materials derived from "primary production," that is, farming, ranching, lumbering, fishing, hunting, and mining, and converts them into new products.

The most cursory study of manufacturing shows us that certain manufacturers tend to concentrate around what must

be specially favorable locations. The question at once arises, why should they? In order to answer this question we must first find out if there are any fundamental factors controlling manufactures. In considering this question we must keep in mind that the manufactured products of any region will have to compete in the world's markets with those of other regions producing similar finished products.

The price at which a commodity can be sold depends upon the cost of producing it; hence, cost of manufacturing must be the controlling factor in selecting a site for manufacturing purposes. The factors which go to control the cost of manufactured articles are, in the main—

(1) The cost of raw materials at the place of manufacture.
(2) The cost of labor.
(3) The cost of power.
(4) The cost of transporting the finished product to the market.
(5) The cost of interest on invested capital.

The above main factors cause manufacturing centres to be located at points—

(1) Where raw materials can be obtained cheaply.
(2) Where a plentiful supply of skilled labor exists.
(3) Where power is abundant and cheap.
(4) Where the market is either near at hand or is easily reached by cheap transportation.

185. The Influence of Supply of Raw Materials. A manufacturing site should, if possible, be near the district from which it obtains its raw materials. If this is not possible then it should be favorably placed on a trade route giving cheap and easy transportation to the district it is to supply.

As an example of the first type we might consider the furniture-manufacturing towns of Quebec and Ontario. They are all near their source of supply of raw material.

The great iron-manufacturing towns of Britain are all situated either on an ironfield with a coalfield near by, or on a coalfield which is close to an ironfield.

As an example of the second type, consider the great textile manufacturing district of Lancashire, which, although far from sources of the cotton supply, leads the world in cotton spinning. This is due to its unrivalled situation on the main trunk steamship route in the world, the North Atlantic route, which gives it cheap connection with the United States, the greatest cotton-growing country in the world.

Influence of "Skilled Labor"—

This is a very important influence. If a country is to be prominent in manufacturing there must be coal for power and

iron for machinery, but the most important requisite of all is an inventive, energetic and skilled people to manage the factories and run the machinery.

The climatic conditions of a region no doubt determine largely the character of the inhabitants. This probably accounts for the fact that the most progressive peoples of the world are those living in the North Temperate zone, more especially in the north-west countries of Europe and the eastern and northern portions of North America. These are the great manufacturing peoples of the world. Wherever coal and iron and an energetic people are found together great manufacturing centres are sure to spring up.

Influence of Cheap Power—

There are five principal sources of power—
(1) Coal.
(2) Water power.
(3) Oil.
(4) Forests.
(5) Winds.

Of these the first three are easily the most important and coal is by far the most important of the three because it is indispensable under our present process of iron and steel smelting. In other industries also coal is meeting with heavy competition from electric power produced by water power.

Modern improvements in electrical transmission have made it possible to locate centres of industry farther away from sources of power than ever before, thus enabling manufacturers to reduce the cost of transporting materials. Regions where either coal is cheap or water power abundant are very likely to become manufacturing centres, more especially if they are situated in the North Temperate zone.

Of the other sources of power, only oilfields are of first class importance. The oilfields have not yet become great centres of manufacturing. Their great importance lies in the portability of oil, which leads us to use it more for transportation work than for actual manufacturing. It is this feature of oil which is revolutionizing transportation both by land and sea. It is unlikely that oilfields will ever supplant coalfields or water power sites as manufacturing centres.

Influence of Accessibility to Markets—

Not only should manufacturing sites be situated in regions where they are accessible to raw materials and power, but they should be near good markets, or at least accessible to them by cheap transportation.

One of the great factors increasing the cost of a manufactured article is the cost of transporting it to markets. Therefore, any advantage a place may possess with regard to this factor is of great importance.

The great business centres of the present day all pay great attention to transport facilities for reaching the market easily and cheaply.

Other Influences—

In addition to these main causes there are sometimes local conditions which make a particular place suitable for a particular type of manufacture. For example, the air of Ulster has exactly the right amount of moisture for the successful manufacture of linen. It is for this reason mainly that Belfast and its vicinity are noted the world over for their linens. Some rivers have water which is peculiarly suitable for the "retting" of flax; for example, the River Lys in Belgium. Hence the city of Courtrai and the linen industry of the district.

In most cases a great manufacturing town possesses not merely one but a combination of advantages, and a study of its manufactures in the light of its geographical position usually discloses the reasons why this or that manufacture has developed there.

186. Examples. Belfast, as we have seen, possesses special climatic advantages for the manufacture of linen. Belfast is, however, also a good port and is situated directly opposite, and quite close to, the Scottish coalfield of Ayr and the English coalfield of Cumberland. Hence fuel for power is easily obtained. As for accessibility to markets, consider its nearness to the great populations of the Scottish lowlands, the Lancashire and Cheshire Plain, and the Yorkshire cities via Liverpool and the Aire Gap. London is also easy of access. Then, again, the water communication of Belfast with Liverpool and Glasgow places it in quick communication with all the world's great ocean trade routes.

The city of Cleveland, Ohio, combines several advantages which fit it to be the centre of a great iron industry. Coal is obtained from the Pennsylvania coalfield, iron ore from Lake Superior, and limestone flux from islands in Lake Erie. Cleveland's position on Lake Erie gives it in addition one of the finest situations in the world for water transport and communication.

Pittsburgh and Alleghany City in Pennsylvania are situated on the navigable Alleghany river, a tributary of the Ohio, in a coal and iron region which also yields natural gas.

Montreal, since the deepening of the St. Lawrence, is another example of a manufacturing city which combines great advantages for obtaining raw material with equally good facilities for manufacturing and distributing its goods. The Great Lakes, and the system of canals connected with them, bring the raw materials of the interior into its factories. Its magnificent river, navigable for large ocean steamers, brings the produce of other lands and immigrant labor. Montreal obtains coal from fields

to the west, south, and east, with which it is connected by river, canal, lake and sea. It has also abundant water power available for electrical power development.

Britain is especially well situated to be an important centre of the cotton-manufacturing industry. Raw cotton ranks second only to wheat in the imports of the country, and cotton goods form exactly one-quarter of the exports from that country. The industry is confined almost exclusively to the Lancashire and the Lanarkshire coalfields. Britain owes her great trade in cotton to the following geographic considerations:

(1) Local supplies of iron and coal, for making and driving machinery, respectively, are abundant.
(2) A damp climate facilitates the spinning and weaving processes.
(3) Facilities for importing the raw cotton are splendid by virtue of the position of her ports with regard to trade routes, viz.: Liverpool and Manchester for Lancashire, and Glasgow for Lanarkshire.
(4) Ease of obtaining chemicals for bleaching and dyeing. These are manufactured in England out of the salt of Cheshire by the use of local coal.
(5) A skilled and large population. Nowhere in the world is there to be found a population so skilled in the manufacture of cotton as is found in Lancashire.

The city of Leeds is noted the world over as the centre of the woolen industry. The industry is concentrated in the west riding of Yorkshire.

The special advantages of Leeds for this industry are as follows:

(1) Nearness to supply of raw materials, viz.: the local supply from the Pennine moors.
(2) Streams of suitable water for washing the wool.
(3) Easily accessible supplies of coal.
(4) Excellent facilities for importing supplies of foreign wool, and also for exporting manufactured goods to the colder countries of Europe, afforded by the estuary of the Humber and its connecting rivers. Connection with Liverpool via the Leeds and Liverpool canal through the Aire Gap gives access to the North Atlantic trade route.
(5) Coal and iron are also found abundantly.
(6) The population is dense and highly skilled.

Examples such as these may be easily multiplied, but enough have been considered to illustrate the principles involved. Carefully consider any others which may suggest themselves. Do not be afraid to use an atlas.

187. Coal. In the development of manufactures the possession of some source of power is a determining factor in deciding what part a nation or city will play.

The most readily obtainable form of power which we have is coal. Today "Coal is King."

The general public has been dependent upon coal for such a long period that it has forgotten what it would mean should it be suddenly deprived of it.

Coal is one great commodity upon which the vast fabric of our modern civilized life has been built.

It is only when some nation-wide coal strike, or world calamity like the late war, causes a shortage of this commodity that we are forcibly reminded of the completeness of our dependence upon it.

The commerce of the world is a "coal-driven" commerce; the manufacturing of the world is accomplished in a "steam-driven factory"; and the steam is produced by the "coal-fired" boilers. The great majority of the homes of the world are warmed and most of our food is prepared by the heating power of coal. It is the use of this commodity which has enabled civilized man in this century, and the last, to extend the habitable zone of the temperate regions nearer to the poles than ever before, and to bring from all points of the earth the materials necessary for his comfort.

It is coal which has given him the power to work mechanical contrivances which far outclass the muscular force of man and beast. Without coal we should be compelled to return to conditions of life such as existed before the industrial revolution.

The principal coal-producing countries are the United States, Great Britain, Germany, these three countries mining approximately 80% of the coal of the world.

188. Coalfields of the World and Their Relation to Manufacturing.

The British Coalfields—

These coalfields produce such an enormous quantity of coal as to make Great Britain the second largest producer in the world. During the period 1922 to 1924 inclusive, this small area produced more than one-half the amount produced on the North American continent, and more than half the coal mined in Europe. In 1924 the British coalfields produced 23½% of the total coal output of the world.

It must be remembered that this vast amount of coal was produced during a period of great industrial unrest and of many coal strikes.

The coal industry of Great Britain is the most vital of all her industries. Her domestic manufacturing is based upon the foundations of cheap coal and iron. Her overseas trade is chiefly maintained by her coal exports.

Britain's imports are chiefly raw materials for her industries and bulky foodstuffs for her dense industrial population. Coal is the export cargo which made British import trade possible.

No other nation sends so much of her coal overseas. The complete dominance of Great Britain in the sea-borne coal trade of the world is shown by the following table:

SEA-BORNE COAL EXPORTS, 1924

Great Britain and Ireland	$391,565,000
United States	37,678,000
Japan	10,770,000
Germany	7,000,000

This, of course, does not include $90,654,947 worth of coal exported from the United States to Canada in 1924.

The total German exports of coal in 1924 were valued at $94,080,270. Of this, over $87,000,000 worth was sent by rail, canal, or river to Austria, France, Belgium, Russia, Switzerland, Italy, and the Balkan States.

There are more than twenty producing coal fields in Great Britain and Ireland. Six of them produce the great bulk of the coal, viz.:

(1) The Northumberland and Durham field, surrounding Newcastle and sending coal to the Baltic region and London. The principal manufacturing industries on this field are shipbuilding and iron manufacturing. The iron ore is obtained from the Cleveland district of Yorkshire, and Sweden.

(2) The Yorkshire-Derbyshire and Nottingham coalfield. Almost the whole output from this division is used to support the woolen, lace, and iron and steel industries centering in Leeds, Bradford, Sheffield, Derby, and Nottingham.

(3) The South Wales coalfield produces excellent anthracite and fine steam coal. This is the chief exporting centre. It also supports large iron-smelting, copper-smelting and tin-smelting industries, the ores being obtained from Cornwall and from Spain, the Malay States, and other overseas countries.

(4) The Lancashire field. This field supports the great textile machinery industry, and the cotton spinning and weaving industry in Lancashire and Cheshire, as well as chemical and glass industries.

(5) The Staffordshire coalfields. These support the pottery industry centred round Stoke, Burslem, and Hanley. The great metal industries of the "black country" around Birmingham and Wolverhampton obtain their coal from this field.

(6) The Forth and Clyde coalfields. These support the great textile industries at Paisley, Alloa, Dunfermline, Dundee, and Galashiels, as well as the machinery, shipbuilding and chemical industries centred around the Firth of Clyde. The Cumberland field supplies the iron-

smelting and shipbuilding industries of Barrow and its coal is carried across the Irish Sea to Belfast. Another field near Bristol provides coal for the cocoa and tobacco industries of Bristol and the West of England woolen industry of Wiltshire. The hosiery and boot manufacturers of Leicester draw their coal from the local field. The carpet industry of Kidderminster is supplied from the Shropshire coalfield.

The German Coalfields—Just as Great Britain dominates the water-borne traffic in coal, so Germany dominates the land traffic. It must be remembered that much of the German coal is of a low quality lignite. This lignite coal is briquetted before being used. It is not largely exported, but is mainly used for the domestic supply.

The largest producing German field is the Ruhr field of Westphalia. This field normally produces about 60% of the German bituminous coal. On the Ruhr field are the great iron manufacturing centres of Essen and Dortmund.

During 1923 the Ruhr coalfield was occupied by the French with a view to collecting the war indemnity payments from Germany. This resulted in so upsetting the industry that the Ruhr coal statistics since the war are of little use. Therefore the normal figures quoted above are those of 1913.

The Upper Silesian Field—In pre-war days this field was much greater than at present, a large slice of it having become a part of Poland. Its coal is of lower grade than the Ruhr coal and the location is not nearly so favorable. Other German coalfields are found in Saxony near Zwickau; in Rhineland around Aachen. Lignite is mined extensively in Saxony, in Thuringia and the Elbe Valley. These coalfields support great iron and steel, chemical, dye and textile and porcelain industries.

The French Coalfields—The largest coalfields of France lie in the Valenciennes basin in the north. Around this field has been built up the iron and steel industry of France. Here are also centred fine lace and other textile industries. The coal is, however, not sufficient for French needs, and large quantities are imported from Britain, Belgium and Germany.

The Saar Basin, which previous to the war was one of Germany's coalfields, is now under the control of the French, since by the terms of the peace treaty the coal of this region was ceded to France. Saar coal, although not of first class quality, will greatly assist France in her manufacturing industries, since that country is poor in coal resources.

There is a small coalfield near St. Etienne which, together with iron ore of that region, supports a thriving iron manufacturing industry and supplies the power for the Lyons silk, ribbon, and carpet industries.

Belgian coalfields are principally the Namur and the Campine coalfields. These fields support manufactures of iron and steel, glass, textiles, etc. Belgium, although so small a country, is a great manufacturing nation.

Other European coalfields are around Posen in Poland; Donetz in Russia; Most, Chomutor, Teplice and Falenov in Czecho-Slovakia.

American Coalfields—The Coalfields of the United States—

The Appalachian coalfield—This is the most important coalfield in the United States as to:

(1) Its extent and present output.
(2) The high quality of the coal.
(3) Its favorable geographic location.
(4) The ease with which the coal can be mined.

The central and northern parts of this field are the principal sources of coals for coke used in the iron-smelting industry of the United States.

The coal from this field makes up for the main part the return cargoes of Great Lakes freight boats, which move the iron ores from Duluth and Superior. The coal is stored in immense quantities at the head of the lakes during the summer. These stocks are used for power and domestic purposes during the winter months. Immense quantities of it are imported into Canada to supply the manufacturing centres of Ontario and Quebec, and to fuel the Canadian railroads.

The Bituminous Fields of the Interior—There are four of these fields, all of which, excepting the Michigan field, are of great economic importance. They are:

(1) The Eastern Interior Field in Illinois, Indiana and Kentucky.
(2) The Western Interior Field in Iowa, Missouri, Kansas and Oklahoma.
(3) The South-Western Interior Field in Texas.
(4) The Northern Interior Field in Michigan.

The Eastern Interior field produces the best coal of this region. It also has the highest production. Its output competes with the Appalachian coals for the Great Lakes trade. Many great manufacturing industries are centred on this field, including the great automobile industry of America.

The Michigan coal is distinctly inferior and is not much mined at present.

The other fields are also of a lower grade and are principally used for railroad fueling and domestic uses. Little of the coal of these two fields is moved far from the place of production.

The Rocky Mountain Field—The coal of this field is much inferior to any of the previously mentioned coals of the United States. It has only local importance. Its principal use is as domestic fuel for the prairie states.

The Puget Sound Coals—These are used for fueling the shipping of the Pacific coast. The United States' fraction of these coals is small, the greater part of the field lying in Canada.

Canadian Coal Fields—Canada is extremely rich in coal resources, but is extremely unfortunate in their geographical distribution. The late Dr. D. B. Dowling, of the Canadian Geological Survey, in his report to the Twelfth International Geological Congress, said, "Canada has large supplies of bituminous and sub-bituminous coals, situated for the most part in the western interior, but there are also important fields on both coasts.

"On the Atlantic seaboard bituminous coals are extensively mined and are used in general power production, in manufacturing and railroad and marine transportation, as well as in the reduction of iron ore. On the Pacific coast, the bituminous coals are mined for power production and for export.

"The interior fields supply coals of various grades, the coals of the mountainous region of eastern British Columbia and western Alberta being the most important and of the highest grade. In Manitoba and southern Saskatchewan the coalfields supply coals, lignitic in character, that are well adapted to domestic use. The extensive coalfields of Alberta, which contain coals of a wide range of character, form Canada's greatest coal reserve. The interior portion of British Columbia has many coal areas that will be of value in providing coking coal for the smelting of the ores for which the province is famous. The fuels of the Arctic islands may, probably, be mined in the future like the Spitzbergen coals, which lie in about the same latitude." (*Coalfields and Coal Resources of Canada,* by D. B. Dowling. Page 4.)

The Nova Scotia Field—All the coals of this field are bituminous. The largest field is that at Cape Breton. Here the coal mines extend for some miles under the sea. The coal is used as follows:

(1) To supply the great iron and steel works of the British Empire Steel Corporation, which owns and operates the collieries.
(2) Used for other industries and domestic purposes in Nova Scotia.
(3) Shipped to Quebec, New Brunswick and Ontario.
(4) Shipped overseas.
(5) Shipped to the New England States.

New Brunswick Coalfields—These are also bituminous coals. The seams are very thin and can be worked profitably only because they are so near the surface. They are often stripped of the covering of soil and rock and worked like a quarry.

Manitoba and Saskatchewan coals are all lignite coals. They are very high in moisture. This prevents them being shipped

far, since when the moisture evaporates, great loss of weight occurs, and the fuel disintegrates, forming slack coal. They are only used for local fuel.

Alberta possesses bituminous and sub-bituminous coals as well as semi-anthracite coal. The bituminous fields of Alberta are the largest and most valuable in Canada. Many of these bituminous fields yield high quality coals both of the coking and non-coking varieties. The output is restricted at present, owing to the lack of markets within the range of economical transportation.

British Columbia fields furnish both bituminous and lignitic coals. Anthracite is also found in the north. The most valuable fields are in Vancouver Island. The location of these fields at tide water gives them a great advantage for export and ocean fueling. Other valuable fields in the south-eastern part of the province are well situated for supplying coal and coke to the metallurgical industries at Fernie, Nelson, etc., as well as to similar industries in the United States.

Queen Charlotte Islands—There is coal of excellent quality in these islands. This field is not yet developed.

The Canadian Coal Industry—Canada's coal resources are her greatest single mineral asset. They are estimated to constitute 7% of the world's supply, and about 14% of all the coal in the British Empire.

"A peculiar situation exists with respect to Canada's fuel supply. Notwithstanding the enormous coal resources that Canada possesses, over 50% of her consumption is imported from the United States. The Canadian coalfields are situated in the extreme east and in the western provinces, while the great central provinces of Ontario and Quebec, the chief centres of population, are more easily and economically supplied with coal from the nearer coalfields of Pennsylvania and Ohio. Further, there is no anthracite coal in Western Canada, and we have become dependent upon the anthracite output of Pennsylvania for that most desirable of domestic fuels, which is not only the chief domestic or house fuel in Manitoba, Ontario and Quebec, but is imported even into our eastern coal districts."—Quotation from *The Mineral Industries of Canada,* published by The Mines Branch, Department of Mines, Ottawa.

COAL PRODUCTION OF CANADA, 1923.

Alberta	6,854,397	short tons
Nova Scotia	6,597,838	" "
British Columbia	2,823,306	" "
Saskatchewan	438,100	" "
New Brunswick	276,617	" "
Yukon Territory	313	" "
Total	16,990,571	
Value		$72,058,986

WORLD'S COAL OUTPUT, 1923

(In thousands of metric tons.)

Country—		1923
Great Britain		280,430
Germany		62,225
Saar area		9,192
Alsace-Lorraine		4,166
Upper Silesia		26,630
France		37,680
Belgium		22,922
Poland		36,098
Russia		11,952
Austria		158
Czecho-Slovakia		12,347
Hungary		851
Roumania		292
Spain		5,972
Holland		5,278
Sweden		420
Spitzbergen		350
Italy		174
Portugal		143
Bulgaria		49
Europe		517,329
Asia		68,485
Africa		11,439
Canada	15,003	
United States	581,364	
America		596,367
Australia		17,300
World		1,210,920

189. Production of Coke, Gas and Gas By-Products. In its natural state, coal cannot be used for most metallurgical operations.

This is especially true with respect to the smelting of iron. The coal is of such a fragile nature that it cannot support the great weight of iron ore and limestone with which the blast furnace is charged.

In order to obtain a suitable fuel for metallurgical processes it is usual to convert the coal into coke. This is accomplished by driving off the volatile matter in ovens. The baking is carried out without admitting air to the oven. The result is that the carbon of the coal is not consumed, but is left behind in a hard porous mass. This is called "coke." It is very solid and is thus able to bear up under the great weight of a blast furnace charge. Its porous nature allows it to burn rapidly and generate intense heat. This latter fact enables the output of the blast furnaces to be greatly increased through its use. Its first use for the purpose of smelting iron appears to have been in 1713, when Abraham Darby succeeded in using it as a substitute for charcoal in the English blast furnaces of that period. Prior to his use of it, all iron was smelted by using charcoal. The enormous amount of charcoal required was the main factor in depleting

the forests of Europe. Until coke was used in blast furnaces the iron-smelting industries were centred around the forested areas of Britain and Continental Europe. Darby's success resulted in the transference of the industry to the coalfields, besides releasing the forests for the production of lumber. Only certain types of coal are capable of producing coke. These are termed "coking coals," whilst the others are "non-coking coals." Practically all coking coals are members of the great class known as bituminous coals. The principal coking coals of North America are obtained from the Appalachian areas. These extend from Nova Scotia, through Western Pennsylvania and Ohio, down to Tennessee, Georgia and Alabama.

Another "coking coal" area is found in the foothills region of the Rockies, and still another in the Pacific coast region of British Columbia. In Europe most of the Carboniferous period coals are "coking coals," although the quality of the coke produced varies very widely. The lignite coals are all "non-coking coals."

Coke is made by two methods—

(1) In the wasteful beehive coke ovens.

(2) In the by-product coke ovens.

The beehive process makes an excellent coke, but allows the valuable gases and other volatile matter to escape.

The by-product oven process collects these volatile liquids and gases. From them are obtained an immense number of valuable products such as dyes, disinfectants, wood preservatives, drugs, etc.

It is regrettable that much of the world's coke is still produced by the old wasteful method of the beehive oven.

The late war, however, led to considerable improvement in this regard, since the Allies found themselves very short in many essential products, which can only be obtained on a large scale from the coking of coal. The result is that many new by-product ovens were constructed and new industries started in countries which were previously dependent upon the worked-up products of the German by-product ovens.

The principal products obtained from by-product ovens and their uses are:

Coke, used for smelting and fuel.

Coal tar, from which many dyes, drugs, local anaesthetics, disinfectants, etc., are prepared. The tar is also used for making building papers and preserving wooden structures. Many munitions of war are also worked up from coal tar. Photographic developers and insecticides and various rubber solvents are also valuable by-products.

Ammonia—Practically all the ammonia used commercially today is one of the by-products of coke and gas manufacture.

The larger part of the ammonia produced in the manufacture of coke is, however, treated with sulphuric acid and converted into the valuable fertilizer known as sulphate of ammonia.

Gas—The gases are used to pre-heat the air supplied to the blast furnace. The pre-heating results in considerable saving in the amount of fuel consumed as well as in increasing the output of iron, by reducing the time required to smelt a charge. Gas is also piped to towns and sold there as a fuel and illuminant.

Coal gas is produced by the distillation of coal in specially designed fireclay retorts. Its principal use is for domestic heating and illumination. A fair proportion is used for the generation of power in small industries in cities. The gases which come out of the retort are very impure, containing ammonia, sulphur, carbon dioxide and tar. These impurities are removed by passing the gas through water and cleaning devices called scrubbers. The ammonia and tar yield the same by-products as in the case of the coke ovens.

The coke produced by gas works is not suitable for metallurgical uses and is used chiefly as a domestic fuel. The European countries are the chief users of this by-product of domestic gas. The eastern cities of Canada and the United States also manufacture it.

Water gas is a city fuel made by passing steam over red hot coke. If required for illumination it has to be enriched with benzines.

190. Water Power. This was one of the first sources of power utilized by man. From very early times until the Industrial Revolution it was man's chief source of power. But the perfection of the steam engine in the latter decades of the eighteenth and the early years of the nineteenth century resulted in its abandonment as a source of large-scale industrial power. The last quarter of the nineteenth century, however, saw a return to the use of water power. This modern use of water powers is due to development of electricity as a source of industrial power. Today great attention is being given to the harnessing of the power of running water. Water as a source of power has one overwhelming advantage over coal or petroleum. This is that its use does not deplete the resource. Every pound of coal consumed, or every gallon of petroleum exploded in a gas engine cylinder means that much power removed from the accumulated stores of the ages, and which man cannot replace. Water power is, however, constantly being renewed by nature. Other great advantages of water power over the other two are: (1) The sources of water power are more evenly distributed about the world than are coalfields or oilfields; (2) Water power can be artificially controlled by man to a much greater extent than either coal or oil. Water power development, nevertheless, depends mainly upon certain favorable geographical conditions. These seem to be:

(1) Adequate precipitation.
(2) Uniformity of stream discharge.
(3) The nature of the slope of the land.

The uniformity of the stream discharge is an extremely important factor in water power development. It is obvious that streams which greatly fluctuate in volume will be irregular in power production, unless some control can be exercised over the flood waters. Uniformity of discharge is obtained naturally by:

(1) Uniformity of precipitation throughout the year.
(2) Regulation by such natural means as—
    (*a*) Forested areas situated on the watersheds;
    (*b*) Natural lakes along the course;
    (*c*) Snowfields and glaciers at their source.
(3) Regulation by artificial means such as storage of waters in reservoirs formed by throwing dams across the stream at favorable points.

A splendid example of the operation of the second type of control is afforded by the St. Lawrence river and the Great Lakes. The St. Lawrence is, all things considered, the finest natural water power site in the world. The reasons being—

(1) Its unrivalled situation with respect to densely populated areas.
(2) Its proximity to the sources of supply for raw materials for manufacturing.
(3) Its ready access to the greatest ocean trade route in the world.

It will be noticed that all of these features are definitely geographical and not economic in their nature.

Water power attains its greatest importance when the industries requiring the power are those which require power alone and not both power and heat. For example: The smelting of ores requires both heat and power, and therefore, power produced from coal or oil suits them best. But transportation, paper and pulp, spinning and weaving, flour milling, etc., require only power. This latter group of industries, therefore, is better served by hydro-electric power.

191. Water Power Resources of the World. The Geological Survey of the United States made a survey of the water power resources of the world as known in 1920. The following are the estimates obtained from this research:

RECAPITULATION OF THE DEVELOPED AND POTENTIAL WATER POWERS OF THE WORLD IN 1920.

	Developed Horse-power	Potential Horse-power
North America	12,210,000	62,000,000
South America	424,000	54,000,000
Europe	8,877,000	45,000,000
Asia	1,160,000	71,000,000
Africa	11,000	190,000,000
Oceania	147,000	17,000,000
Approximate total	23,000,000	439,000,000

(From *World Atlas of Commercial Geology*, Part II, Water Power of the World, Washington, District of Columbia, 1921.)

It will be seen that the continent of Africa has by far the greatest potential water power resources of any of the continents. This is due to several geographical factors:

(1) The structure of the continent, which is mainly a great plateau, dropping abruptly to the sea near the coast. This produces great concentrations of power near the coasts.

(2) The extremely heavy rainfall of Equatorial Africa.

(3) The monsoon effects on the rainfall.

(4) The great rift valleys which provide splendid natural catchment basins to store this water and regulate its flow. (See Section 53.)

The water power resources of the Lower Congo are absolutely the greatest concentrations of potential water power in the world. The lack of development of these resources is mainly due to—

(1) The unhealthiness of the region for Europeans.

(2) The natural characteristics of the natives.

(3) The general backward state of the development of Africa.

(4) The density of the forests of the region.

As the great Bantu races of Africa (a quite distinct race from the coastal or forest negro), come more into contact with civilization, their energy, virility and numbers may, perhaps, result in the development of a black industrial race supplied with power from these unrivalled water power sites.

In North America, the Canadian and United States potential water powers are estimated to be 48,000,000 h.p., of which 11,600,000 h.p., approximately, have been developed. Nearly two and a half millions of the amount developed are Canadian, and about nine and a quarter millions have been developed by the United States.

The South American water power resources are nearly as great as those of North America. They are, however, very poorly developed. This is because—

(1) The major part of them are in regions too unhealthy and swampy ever to be great industrial centres.

(2) South America is relatively isolated.

(3) The native races are decadent, they being in this respect quite the opposite of the Bantus of Africa.

(4) The Andean Chain is a terrific barrier to transportation between the metals of the continent and the consuming regions of the southern end.

Asia, for its size, shows surprisingly small potentialities of water power sites. This is largely due to the aridity of the major part of the continent and to the large areas of comparatively level plain in the north. The greatest concentration of water power is in Northern and North-West India, China, Japan, and Eastern Siberia.

Oceania—All the seventeen million horse-power with the exception of an estimated 620,000 h.p. in Australia, are found on the islands composing this division. New Guinea and New Zealand have the largest shares. But the remoteness of New Zealand precludes very heavy development of manufactures, whilst the climate and ferocity of the natives of New Guinea operate against the development of this rich island.

192. Canadian Water Power. The actual extent of Canada's water power, as of its forests and other natural resources, has been by no means fully ascertained, but it is known to be abundant and well distributed throughout the Dominion, except in the southern portion of Alberta and Saskatchewan.

It is an important and extremely fortunate fact that a large amount of the accessible water power is situated in the "acute fuel zone," a territory stretching for about 1,000 miles east and west and centering upon the Great Lakes, where native coal is not conveniently or economically available.

The distribution of water power by provinces is shown in the accompanying table:

AVAILABLE AND DEVELOPED WATER POWER IN CANADA

Province—	At ordinary minimum flow. Horse-power	Dependable for six months. Horse-power	Turbine Installation. Horse-power
Nova Scotia	20,751	128,264	47,100
Prince Edward Island	3,000	5,270	2,239
New Brunswick	50,406	120,807	42,039
Quebec	6,915,244	11,640,052	1,073,883
Ontario	4,950,300	6,808,190	1,299,230
Manitoba	3,270,491	5,769,444	134,025
Saskatchewan	513,481	1,087,756	.....
Alberta	475,281	1,137,505	33,067
British Columbia	1,931,142	5,103,460	328,977
Yukon and N.W. Territories	125,220	275,250	13,199
	18,255,316	32,075,998	2,973,759

For magnitude, continuity and distribution, few countries can even approach Canada's unique system of fresh water bodies, and its employment in the regulation and control of her waterways is a singular benefit not only in power production but for navigation, irrigation, and other purposes of water supply. Illustrative of this is the situation in the maritime provinces of Nova Scotia and New Brunswick, where recent detailed analyses have disclosed most advantageous reservoir facilities for regulating stream flow, it being estimated, as a result of these investigations, that the two provinces possess within their respective borders 300,000 and 200,000 "commercial" horse-power.

Great Power Rivers—

There are several outstanding power rivers in Canada, which, with their tributaries, form important zones for settlement and industrial expansion. Foremost amongst these is the St. Lawrence river, not only because of its enormous discharge but also

because of the almost complete natural storage of the Great Lakes which feed it. This great river is capable of furnishing over 3,500,000 horse-power, of which less than 1,500,000 horse-power is in the international reach and would have to be apportioned between Canada and the United States.

Of the many large rivers flowing into the St. Lawrence from the northern Laurentian plateau three should be mentioned, the Saguenay, the St. Maurice and the Ottawa. All these three rivers have great lumber and pulp interests located in their valleys, but latterly a broadening field of application to more general commercial and public undertakings has been evident. On the Ottawa river, development has been confined to less than 100,000 horse-power in the vicinity of Ottawa City, leaving still unutilized 21 sites, aggregating 678,000 horse-power, on a basis of ordinary minimum flow, and probably twice that amount with adequate storage. It is from the headwater tributaries of the Ottawa that the silver mines of Northern Ontario draw their main supplies of electrical and compressed air energy.

The spectacular falls and rapids of the Niagara river represent 5,300,000 horse-power with the whole flow of the river, of which 740,000 horse-power is now being employed on the Ontario side alone. Electricity from this source is distributed throughout the peninsula of South-western Ontario and has led to the building up of several highly industrial centres.

Georgian Bay and Lake Superior are fed by numerous streams well distributed and capable of furnishing power sufficient for the probable future needs of these localities. A few plants have already been constructed and are now in operation in response to local requirements. The ordinary minimum flow of the rivers draining into James Bay would furnish nearly 1,000,000 horse-power and about twice that amount for six months of the year.

The Winnipeg river, flowing from the Lake of the Woods to Lake Winnipeg, has played an important part in the history of Manitoba, formerly as a trade route to the west and now as a source of electrical energy for the city of Winnipeg and vicinity. Its present regulated flow gives it a potential equivalent of nearly 500,000 horse-power, of which approximately 13 per cent. is now harnessed. There are several excellent power sites in the rivers of Northern Saskatchewan and Alberta which will prove invaluable for the development of the mineral and timber resources of that region.

The varying topography of British Columbia gives a wide distribution to that province's hydraulic assets. It has been estimated that within a radius of 100 miles of Vancouver there is to be found nearly 1,000,000 horse-power dependable for six months of the year, excluding the many considerable sites on Vancouver Island.

Growth and Status—

Of the country's water power assets only a small portion, about seven per cent. of an estimated total possible turbine installation, has been utilized as yet.

The total hydraulic installation for the Dominion averages 338 horse-power per thousand population, as compared with about 100 horse-power per thousand population in the United States. This figure places Canada second only to Norway in the per capita utilization of water power.

Hydro-electric generation is one of the greatest of Canada's basic industries, while as a manufacturing process it is the largest in the Dominion from the standpoint of capitalization. The capital investment at the end of 1922 aggregated $620,000,000, of which a large portion can be assigned to transmitting and distributing equipment. This figure does not include such industries as electric railways and plants for the production of electrical equipment, which in Canada are to a very large extent directly dependent on water power for their existence. The success of many typical Canadian industries, and the future of many projects now under way or under consideration, is vitally associated with cheap power facilities. This applies notably to the pulp and paper industry, the mining industry, the electro-chemical and electro-metallurgical industry, and the flour milling industry. While the progress of Canadian industry as a whole has been in great part due to cheaply available hydro-power in ample quantities, the aforementioned industries have attained particular eminence as contributors to the world supply of their respective products, largely or wholly by virtue of this advantageous factor.

The influence of water power resources upon national development is exceptionally well illustrated by the pulp and paper industry. In 1890 Canada exported $120 worth of pulp and paper, whereas at present the annual export value of these products is well over $100,000,000. The paramount importance of cheap power as a factor in this growth may be judged from the fact that it takes practically 100 horse-power to make one ton of paper per day. The motive power used in the industry is virtually restricted to hydraulic energy, and Canada's prestige in this field of industrial activity rests on abundant water powers strategically situated among extensive forest areas. A total of 546,000 hydraulic horse-power is used by the pulp and paper companies. Of this total, 484,000 horse-power is developed by the industry itself and the remainder acquired by purchase.

Similarly, though perhaps in less striking fashion, water power has stimulated and supported mining. Canadian gold, silver, nickel, and other mineralized properties have yielded very substantial outputs, and in many cases large-scale operations, which alone made the difference between profit and loss, would have been impossible without ample hydraulic energy at relatively low cost. Many mines are so placed geographically that

the cost of rail haul on coal or untreated ore would be prohibitive, but with hydraulic installations at or near the mines they can be worked and the product so concentrated as to permit profitable operations. Extensive electro-chemical and electro-metallurgical industries have been established in Canada through the attraction of exceptional power advantages, nearly 100,000 horse-power being used, and it is expected that the near future will see further substantial progress in these directions. Among such products commercially produced in Canada and using hydraulic energy in their manufacture are aluminum, phosphorus, carbide, carborundum, cyanamide, caustic soda, chlorine, artificial graphite, etc. The successful application of the electric furnace to Canada's iron and possibly copper ores may ultimately prove the basis of a new industrial development of more than ordinary proportions.

Relation to Agriculture and Transportation—

Through the agency of electrically transmitted energy the Dominion's water powers promise to exert a marked influence upon the conditions of rural life and the course of future agricultural development. The Hydro-Electric Power Commission of Ontario, distributing hydro-electric power over a very broad field, is giving every encouragement to the use of electricity in rural districts. Its valuable example will doubtless be followed as soon as conditions permit by public and private enterprise elsewhere, and electric facilities should in due course become a prominent and regular feature of Canadian rural life.

The relation of water powers to transportation in the past has been indirect but of substantial benefit. They have permitted the development of industry in areas which otherwise could not have contributed appreciable revenue to the railway system. Today a more definite relationship is being proposed in the electrification of railways. There are many indications that the time is not far distant when water power will replace coal, in part at least, on Canadian railways.

Reduces Coal Handicap—

Aside from its effect upon specific industries, such as pulp and paper manufacturing, mining and others, water power has been of inestimable value in minimizing the severe industrial handicap imposed by the lack of coal deposits in the Dominion's most populous provinces. Ontario and Quebec, the two provinces most heavily handicapped in respect to coal, are very liberally endowed with water power. While the Dominion as a whole is compelled to import large quantities of coal each year, the degree to which water power has relieved the situation is indicated by the fact that present water power development represents an annual equivalent of nearly 27,000,000 tons of coal. The imports of coal are to a certain extent further offset by Canada's exports of hydro-electric power. Canadian power is sold to the United States at present by exporting companies variously located in the provinces of New Brunswick, Quebec,

Ontario and British Columbia. The amounts of power exported for the fiscal years ending March 31, 1919, 1920, and 1921, were 175.013 h.p.-years, 143,003 h.p.-years and 156,017 h.p.-years, respectively. This may be taken as offsetting approximately 1,500,000 tons of the coal imported annually from the United States.

(The above resumé of Canadian water powers has been extracted verbatim from the booklet *Canada—Natural Resources and Commerce*, Chapter IV, issued by the Department of the Interior, Natural Resources Intelligence Service, Ottawa, 1923.)

193. Petroleum. The twentieth century has been marked, so far, by the development of the use of petroleum. Leadership on the sea and in the air seems to be rapidly becoming dependent upon the possession of fuel oil and gasoline. Hence the spectacle of the nations struggling for the control of the potential oil fields of the world. Petroleum is used mainly as a source of power, light, and lubricants. Since the dawn of the present century great steps have been made in the development of great by-products industries resulting from the distillation and cracking of the crude petroleum. This development of the use of petroleum and its products is somewhat analogous to the utilization of the by-products from coal inaugurated by Sir Wm. Perkins' epoch-making discovery of the mauve dye in 1856. The number of refined products obtained from petroleum is enormous. Some are used as local anaesthetics. The gasolines are universally used as fuel for internal combustion engines.

The kerosenes are used for lighting purposes and for fuel for farm tractors. Machinery, both high and low speed, depends largely upon them for lubricants. The waxes are used for candles, preservatives, chewing gum base, surgical dressings, etc. The coke left in the retort is used to produce power in industrial plants, etc. Heavy oils, obtained from distilling petroleum, are used to spray on streets and highways. Asphalt is another product used in road-making. Petroleum is widely distributed geographically. The search for it has become world-wide, and today a new profession, that of the petroleum engineer, has arisen.

Petroleum is usually obtained by boring wells. The oil may be pumped up or it may gush forth under great pressure. It is sometimes mined in the same manner as coal. Shafts are sunk, and galleries driven into the rocks which contain the oil. The oil flows down to the bottom of the galleries, where it is drained away to a central pumping pit, and pumped to the surface.

This method is actually in operation today at Pechelbron in Alsace. It is claimed that this method recovers a greater percentage of the oil than the boring method. The crude petroleum is transported from the oilfields to the centres of consumption in four main ways—

(1) By great pipe lines.
(2) By tank cars on railroads.
(3) By tank steamers.
(4) By barges and river steamers.

The inflammable nature of petroleum is one of the main difficulties in the transportation and storage of the commodity. Barrels were first used, then tank cars and now pipe lines are favored where the traffic is heavy enough to stand the expense.

For overseas transport the "tanker" is now all but universally employed.

The mileage of the oil pipe lines of the world is stupendous. The oil from the West Pennsylvania fields is piped over the Alleghany Mountains to New York, Philadelphia and Baltimore. The Indiana and Oklahoma fields send their oil from the fields to Chicago and to the Gulf of Mexico through pipe lines.

The oilfields of Baku, on the Caspian, are connected by pipe line to Novorossiysk and Batoum, on the Black Sea.

WORLD'S PRODUCTION OF PETROLEUM.

Country—	1923		*1924	
	Metric Tons	Per Cent	Metric Tons	Per Cent
United States	100,371,000	70.65	99,622,000	69.35
Mexico	22,704,000	16.05	21,622,000	15.08
Russia	5,435,000	3.82	6,653,430	4.85
Persia	3,836,000	2.70	4,603,200	3.20
Dutch East Indies	2,833,000	1.99	2,833,000	1.99
Roumania	1,512,000	1.06	1,811,600	1.26
India	1,168,000	.82	1,157,000	.80
Peru	752,000	.63	814,000	.56
Poland	733,000	.51	670,100	.47
Venezuela	618,000	.43	1,157,200	.86
Sarawak	567,000	.39	657,600	.45
Argentina	497,000	.35	511,600	.35
Trinidad	424,000	.29	486,500	.33
Japan	248,000	.17	220,100	.16
Egypt	153,000	.11	147,100	.10
France	57,000	.04	56,600	.04
Colombia	61,000	.04	71,700	.05
Germany	44,000	.03	45,700	.03
Canada	23,000	.01	22,300	.01
Czecho-Slovakia	11,000	.....	11,000	.....
Other countries	20,920	.....	22,010	.....
Total	142,067,920		143,195,740	

*Estimated.

Petroleum Production of Canada—

The supply of crude petroleum comes almost entirely from Ontario. New Brunswick and Alberta also produce a little. The search for oil in Alberta is being prosecuted with great vigor, and there is now no longer any doubt that there are great potential oilfields in this province. At present the Turner Valley oilfield near Okotoks is the main producer. The Ontario fields are situated in the peninsula of South-western Ontario between Lakes Huron and Erie. Petrolia is the principal centre.

PRODUCTION IN 1923.

Ontario	159,400	Barrels
New Brunswick	8,826	"
Alberta	1,943	"
Total	170,169	"

194. Natural Gas. Natural gas is a very important and practically ideal domestic and industrial fuel. Its use is pretty generally confined to the districts contiguous to the location of the wells. It is used as a fuel in many glass works, cement plants, brickyards, factories and metallurgical plants. It is also a valuable source of "carbon-black," which finds a large use as the basis of printers' ink, etc. Many of the fields on the North American continent yield a gas which contains notable percentages of helium gas.

Natural gas is, when pure, odorless and colorless. It burns with a pale blue flame. When mixed with air it is highly explosive. The gas as obtained from the wells is classified as either "wet" or "dry." Wet gas contains relatively large percentages of gasoline. It is usually found along with oil and is often obtained from the same wells as the crude oil.

The gasoline content can be rather easily extracted and furnishes a fair supply of naturally distilled gasoline in certain fields. This is the case in the Turner Valley field of Southern Alberta. Dry natural gas contains no vapors of gasoline and other lighter oils.

The natural gas fields of Alberta, around Medicine Hat, Bow Island, High River and Viking, are important sources of heating fuel for Alberta cities. The gas is piped from the wells to the various towns and cities, where it is distributed through a network of subsidiary feed lines to the householders. Industrially it supplies the clay products industries and the glass works of Medicine Hat and Redcliffe with a very convenient source of heat.

Canada is the second largest consumer and producer of natural gas in the world, the United States being the greatest. Italy is also a large consumer and producer.

Helium is now used for inflating military balloons and dirigibles, since it is absolutely non-inflammable. For this reason it is superseding the use of the highly inflammable hydrogen, previously universally employed for this purpose.

195. Bituminous Sand. At present the difficulties attending the extraction of the oil from bituminous sands prevent it from competing with the crude oil obtained from wells. It must, therefore, be looked upon as a potential asset. In Northern Alberta, near Fort McMurray, is found the largest known body of this material in the world. Considerable research is being carried out with a view to making this enormous body of material available for use in commerce and industry. Up to the

time of writing, however, (1925) nothing very spectacular has been achieved, although at the University of Alberta considerable success has attended the effort. The work is directed by the Scientific and Industrial Research Council of Alberta. The main object of the research is to enable this vast body of material to be used as a road-making material for the prairies. Experimental pavements have been laid down, and the results of these tests are being awaited with interest.

Dr. Clark, who is in charge of this work, in summing up his annual report in 1923, says: "Two practical experiments carried through during the year have been gratifying and encouraging in their results. The bituminous sand separation plant demonstrated the soundness of the preliminary laboratory work on which its design was based, and indications are that a commercially feasible separation process has been evolved. The attempt at practical construction of bituminized roads has also carried the efforts of the Industrial Research Department to work out a serviceable type of prairie rural road to a practical stage. Plans are being made for the coming year to carry out further tests along both these lines of investigation."—Page 72, *Fourth Annual Report of the Scientific and Industrial Research Council of Alberta,* Edmonton, 1923.)

There are several other deposits of bituminous sands in other parts of the world, notably in California; and in the Island of Trinidad there is an immense deposit of asphalt. The Trinidad asphalt is one of the most important sources of road-material in the world. The asphalt is obtained from the world-renowned Pitch Lake of the island. The Trinidad asphalt has the advantage over all other similar deposits of paving material in that it occurs at tidewater and near a great ocean trade route. Practically all the bituminous roads the world over are made with the Trinidad asphalt.

196. Other Possible Sources of Power. The sources of power just discussed are by no means the only ones available to man. They are simply the sources over which he has gained control. As a matter of fact they contribute little more than a very small percentage of total power of the globe. There is little doubt that in the future man's increasing knowledge of science will bring many more power sources under his control .

At the present there are three mighty forces which are being attacked by scientists and engineers, the harnessing of any one of which would materially alter the present condition of things. These future possibilities of power are:

(1) The tides.
(2) The direct utilization of the sun's energy.
(3) The control of atomic energy.

197. The tides are the result of the combined actions of gravitation and planetary momentum. The amount of power

developed by them every twenty-four hours is stupendous. For many hundreds of years the utilization of this force, as a source of power, has been the dream of engineers and scientists.

Several attempts have already been made to take advantage of tidal energy, but so far the successes have been indifferent. Sir Hugh Myddleston, the goldsmith who gave London its first waterworks, attempted to use the tidal energy of the Thames by means of "tidal mills."

At present the ebb and flow of the tide in the Seine estuary at Havre is made to work turbines. These turbines are used to generate electricity. The great tidal bore of the Severn River in England has been the subject of several schemes. At the present time it is proposed to dam this estuary. The proposed scheme, it is said, would yield half a million horse-power of energy. The wonderful tides of the Bay of Fundy are also being considered, and schemes are, from time to time, being propounded with a view to utilizing the enormous energy which they represent.

A French engineer, R. Esnault Pelterie, has proposed a vast tidal power system to utilize the high tides of the English Channel. So far, the magnitude of the construction work required for any one of these schemes is such that adequate capital for the purpose is not forthcoming. At the present time it does not appear at all likely that they will be carried out. They must wait until the other sources of power become so seriously depleted as to call for such drastic measures to supply our power demands.

198. The Direct Utilization of the Sun's Energy. All our energy comes originally from the sun. Up to the present, man has not been markedly successful in making use of this enormous amount of energy in any direct manner. Indirectly he uses it in the form of water power, coal, petroleum, wind, etc. About a hundred years ago the natural acumen of George Stephenson enabled him to point out that it was really the sun's energy which operated his locomotives. He was in the habit of referring to coal as "bottled sunshine." Since his day science has only confirmed his views.

In recent years many attempts have been made to harness the direct heat energy of the sun. At the present time there is a plant operating near Cairo in Egypt. The results from this experimental plant are encouraging. It is used for pumping water for irrigation purposes. The chief drawback to its more extended use is the high cost of the power obtained. Still a beginning has been made and in the future, it may be, many of the hot deserts of the world may furnish power from the direct use of the solar heat.

199. Atomic Energy. Science has shown in recent years that each atom is a veritable mine of energy. The trouble is that we do not at present possess the means of liberating and

harnessing this energy. Many physicists are struggling with the problem. The rate at which scientific discovery is progressing in these days bids us hope that before long the secret will be found. Man, it is then thought, will be placed in possession of a source of power hitherto undreamed of.

200. Industrial Alcohol. This is undoubtedly the most promising future source of power immediately available.

The greatest possible stress should be laid on the part that alcohol is going to play in the industrial future of the world. We have become so used to the internal combustion engine, or gas engine, that we accept it as part of the natural order of things. But it is only thirty-seven years ago that Daimler introduced the first petrol-driven motor (that is to say, in 1890). Since then they have been improved and their production so increased and cheapened that today we should find it strange indeed to be without automobiles or motor trucks. The farmer and the small manufacturer would be sadly handicapped without their small gas or oil engines. Yet the continued use of the internal combustion engine depends upon an adequate supply of liquid fuel. Today the visible supply of gasoline and coal oil is scarcely adequate to meet the prospective demands upon it. The logical successor of gasoline is alcohol, which can be used in exactly the same manner as gasoline. Alcohol is far safer and infinitely more pleasant to use. It has not quite so much power gallon for gallon, as gasoline, but when produced for industrial purposes only, and treated so as to make it unfit for human consumption, alcohol can be produced for about twelve cents per gallon. At this price it would soon take the place of gasoline at thirty cents per gallon.

Its advantages over gasoline are:

(1) Small liability to explosion.

(2) Greater compressibility without danger of explosion.

(3) Cheapening of insurance risks, especially in the case of motor boats.

(4) It does not burn with such a disagreeable odor as gasoline.

(5) Alcohol fires can be extinguished by water, while gasoline fires are only spread when water is used to put them out.

(6) It can be manufactured anywhere by simple distillation of vegetation. Such common products as potatoes, beets, straw, etc., are eminently suitable.

(7) Gasoline is extracted by distillation from crude petroleum. This necessarily means that it must be transported long distances. The inflammable nature of the product also requires special means of transport, which again add to the expense.

Germany has realized the value of alcohol due to the rapid depletion of the gasoline supplies of the world. In consequence the Germans have developed the alcohol engine to a high point of efficiency. In 1904 there were 3,000 alcohol engines in use in Germany. In 1906 there were 6,000. In other words, their use was doubled in two years. During the late war Germany used alcohol almost entirely in her motor transport. Prior to the war the Germans paid eighteen cents per gallon for alcohol made from potatoes. This alcohol was produced in 6,000 farm distilleries.

201. The internal heat of the earth and volcanoes have been considered by some as a possible source of power in the future. Many schemes have been suggested, but none have met with any measure of success.

202. Iron. This is by long odds the most valuable metallic substance known. Its uses are far too numerous to specify, and the commoner uses are so well known that enumeration would be superfluous. No other metal has been found capable of taking its place.

Iron must have been known and used for more than 5,000 years, since an iron implement was found sealed up in the wall of the Great Pyramid of Gizeh.

The full realization of the wonderful properties and the development of the manufacture are essentially, however, achievements of modern times. In 1740 the total production of iron and steel in Great Britain was estimated to be about 18,000 tons. In 1922 Great Britain produced 10,731,400 tons, while the United States contributed 62,822,830 tons, Germany 17,544,000 tons, and France 9,599,865 tons.

Ores of iron are distributed all over the world. But the possession of a large body of the ore does not mean that a country will of necessity be a great source of supply for the metal. Other factors are necessary before a nation can develop a great iron industry:

(1) The ore must occur in a section of the country where transportation is cheap and reliable.

(2) It must occur in regions where the necessary fuel (coking coal) and flux (limestone) can be readily and cheaply obtained.

The United States, Germany, Great Britain, and France are examples of countries whose deposits of iron ore are favorably situated from these points of view. They are also the four great iron-producing countries of the world.

Extensive iron-making is an industry of countries advanced in manufacturing. This industry requires excellent transportation facilities, an abundant labor supply of a highly skilled type, and men of the highest organizing capacity to direct the work. Large supplies of capital are necessary to build and operate the

enormous plants required. As a result, six countries dominate the iron-making of the world, and of these six, four may now be classed as major, and two distinctly minor, as a result of the redistribution of territory after the world war.

The major group, viz.: the United States, Germany, Great Britain, and France, produced 100,698,095 tons of iron and steel in the year 1922, which is more than four-fifths of all the iron and steel produced in the world. Belgium and Russia constitute the minor group, and after their contribution is added to the above, there is little left to the credit of the rest of the world.

203. World Commerce in Iron. The large-scale production of iron is localized in a few districts fringing the Eastern and Western coasts of the North Atlantic Ocean, but its commercial distribution is world-wide. All people who trade use it in many forms, so that the manufactured products of England, Germany, and France from the European coasts and from the United States on the American coast, are sent to every country.

The European countries send principally the more highly finished forms such as cutlery, tools, instruments, and the finest machinery. From the United States go, principally, labor-saving machinery, and the heavier products like railroad steel, bridges, girders, boiler plate, and pipes.

204. Iron and Steel in Canada. Sydney, on Cape Breton island, is the centre of the iron and steel industry of Canada. Here are found huge deposits of coal and limestone, but the ore utilized is Newfoundland ore, which is brought from Bell Island in Conception Bay, Newfoundland. This is an instance of a great iron and steel industry made possible solely by the fact of cheap transportation.

Hamilton, Ontario, is the second most important iron centre in Canada. Here both fuel and iron ore are imported and the flux is obtained locally. The fuel comes by rail from Pennsylvania and the iron ore by lake steamers from Minnesota.

Sault Ste. Marie is the third important centre. The ore here is brought from the Canadian shore of Lake Superior, while the fuel is brought by water from Pennsylvania.

Both the two Ontario centres have arisen because of the availability of cheap hydro-electric power for the subsidiary manufactures of plows, harvesters, and electrical machinery, together with the proximity of markets for these manufactures and favorable transportation facilities.

205. Outline of the Manufacturing Process. Iron is different from most other metals used in the industries in that it has little commercial application in the pure state. The presence of small, even minute quantities of several other elements causes very marked modifications in the properties of the finished

product. Some of these are beneficial. Some are so harmful that the slightest trace left in the iron may ruin it for many purposes. This is not the place to consider the modifying effects of these substances, nor the methods adopted to remove, retain, or add them to the finished commodity. For further information some modern text on inorganic chemistry should be consulted. The authorized text for Grade XII Chemistry would be suitable. All that we need to realize, in the study of geography, is that the production of commercial iron and steel is a highly complex process. Its successful accomplishment depends upon the utilization of wide chemical knowledge and high engineering skill, in order to obtain the necessary large-scale production which the cheapness of the product demands. Hence, the leading iron and steel-producing countries are, of necessity, those nations which we commonly regard as the leading powers of the world. (See Section 202.)

Outline of the process of iron and steel manufacture:

(1) The iron ore is mixed with limestone and coke or charcoal.

(2) It is then heated by forced blast in a blast furnace, producing pig iron.

(3) The pig iron is remelted and either sold direct as cast iron, or

(4) It may be annealed, yielding malleable cast iron, or

(5) It may be remelted and sold as grey or chilled cast iron, or

(6) It may be converted into "wrought iron" by puddling and hammering or squeezing. This product may then be converted into crucible steel by heating with charcoal and remelting.

(7) The pig iron may also be converted rapidly into Bessemer steel by conversion in a Bessemer converter. This is the most rapid process, but is not suitable for all types of pig iron, or

(8) The pig iron may be converted into steel by the open hearth process. This process may be used on all types of pig iron and produces any variety of steel required. It is much slower than the Bessemer process, but its great advantages of variety of product and availability make it now the most widely used process.

Much work is being done, especially in Canada, in the application of electricity to the large-scale production of iron and steel. Canada's lack of fuel near her great reserves of iron ore, and the nature of the impurities existing in those ores, make it imperative that some new method of production be discovered.

WORLD'S IRON AND STEEL OUTPUT.

IN THOUSANDS OF ENGLISH TONS.

Countries—	Pig Iron		Steel Ingots and Casting.	
	1924	1923	1924	1923
United States	31,000	40,026	37,800	44,944
Great Britain	7,400	7,440	8,250	8,492
France	7,500	5,346	6,850	5,029
Belgium	2,800	2,154	2,850	2,250
Luxemburg	2,125	1,384	1,850	1,182
Germany	8,200	4,400	8,500	5,900
Czecho-Slovakia	700	750	800	1,000
Poland	500	492	950	935
Japan	350	300	550	500
Other countries	4,055	4,179	5,175	4,864
World total	64,630	66,471	73,575	75,096

206. Forest Industries and Paper.

Location of the Centres of Lumbering Industry and Nature of Their Products.

The use of wood is universal. For ages it has been, and still is, used in immense quantities as a fuel. Until the advent of the steam-driven vessel in the early years of the nineteenth century it was the material of which all ships were built. Even today the shipbuilding industry uses large quantities of wood for the finishing of ships, both inside and out. The railroad engineer requires it for ties and bridges. Incredible amounts are used annually for the manufacture of boxes in which to transport the materials of commerce. In many countries it is still the principal source of materials for buildings. The finer kinds of wood are made into furniture and used in the finishing of our homes and public buildings. The paper industry is practically dependent upon the forest. The industry concerned with the obtaining of wood is known as the "lumbering industry." It is almost entirely at the present time an extractive industry, although the increasing uses of wood and the rapid depletion of the forested areas of the world are forcing man to reconsider his methods in this respect. There is no reason why lumbering should be a purely extractive industry. Today the industry is being gradually converted into a productive industry. This is being accomplished by the introduction of scientific forestry. The subject of scientific forestry will be discussed later. The lumbering industry has three distinct branches, viz.:

(1) The logging industry.
(2) The saw-mill industry.
(3) The planing-mill industry.

Logging consists in felling the trees, branching them and cutting them up into convenient lengths for transportation. The industry is seasonal, most of the cutting being done in the winter. This is because the winter snows have to be utilized in transporting the logs to the saw-mills. Lumbering is very dependent upon transportation. This is because lumber is very

bulky in proportion to its value, and also because it is secured mostly in rugged regions where roads are difficult to construct. The sparsity of population in such districts also operates strongly against the industry since it results in little demand for the products. The transportation is usually accomplished by taking advantage of the rivers and streams, down which great drives of logs are carried every spring. Near lakes and the sea coasts the logs are built into huge rafts and towed to the saw-mills. Sometimes railways are built into logging regions. The river driving and the rafting methods are, however, the principal means of transport.

Saw-mills are located as near the logging regions as possible since rough sawn lumber is easier to handle than the logs. The mills are of two main kinds, viz., portable and permanent. The portable mills often follow the logging operations for great distances up the streams. The mills are furnished with power from waterfalls or else they produce steam by consuming the slab sides and other waste products of the sawing industry. The planing mills further dress the rough sawn lumber into smooth planks and such standard articles of construction as doors, window sashes, etc. These mills are generally located at or near the centres of consumption, the reason being that well-finished material suffers more from transportation and storage than rough lumber.

207. Centres of Lumbering.

Canada. There are three main areas of forest growth in Canada. They are:

(1) The Cordilleran Forests.
(2) The Forests of the Great Plains.
(3) The Eastern Forests.

The Cordilleran forest is almost entirely in the province of British Columbia, although it penetrates into Western Alberta and the Yukon district.

British Columbia contains over two-thirds of the merchantable saw timber of Canada. The greater part of this huge supply is found on Vancouver Island, Queen Charlotte Islands and the mainland opposite.

The forest is mainly coniferous and contains the following important woods:

Douglas fir	22%
Western cedar	22%
Spruce	21%
Western hemlock	18%
White fir or balsam	9%
Other species	8%

The Great Plains Forest Areas. The forests of the Prairie Provinces of Canada and of the eastern slopes of the Rocky Mountains are of entirely different character from those of the

Cordilleran region. Spruce and jackpine are the principal conifers of these regions, but small stands of balsam fir and tamarac are also found. The various poplars comprise about one-third of the trees. Some birch is also obtained. These woods have no export significance.

The Eastern Forests. The St. Lawrence basin and the Great Lakes region form the most important commercial forest area in Eastern Canada. White pine, white spruce, and balsam are the most valuable species. The clearing of the land for agricultural purposes has seriously diminished the supplies of such valuable hardwoods as walnut, maple, ash, elm, and hickory, for which this region was at one time so famous. Of the other species, hemlock and red pine furnish valuable structural timbers. Jackpine is converted into railroad ties and cheap grades of lumber. White cedar is a valuable shingle material.

The forests of New Brunswick and Nova Scotia are also very valuable commercially. They furnish most of the varieties of timber found in the Great Lakes region, and in addition great quantities of red spruce.

208. Centres of the Industry. The Ottawa Valley and the Georgian Bay districts are the leading lumbering regions of Eastern Canada. New Brunswick is also very important. The province of British Columbia, however, is the leading province, cutting almost one-third of the total production of Canada. The industry in British Columbia is mainly centred around Vancouver and on Vancouver Island. The Prince Rupert branch of the Canadian National Railway has opened up a large area for lumbering purposes, and many large mills are now operating along its tracks.

209. Canadian Lumber Production. Canada ranks second in the list of the world's lumber-producing countries. The total value produced in 1922 was $84,554,172. This was the product of 2,922 mills. By provinces:

Prince Edward Island	$ 3,472
Nova Scotia	2,509,912
New Brunswick	8,906,894
Quebec	17,489,026
Ontario	25,687,380
Manitoba	1,371,062
Saskatchewan	283,922
Alberta	649,791
British Columbia	27,571,142

210. Other Countries. The United States is the leading lumber-producing country in the world. The lumber is obtained from seven main districts:

(1) The upper New England and Adirondack forests.
(2) The forests of the Great Lakes.
(3) The Appalachian Highlands forest.

(4) The hardwood forests which extend from New York to Alabama and from Alabama to the Ozarks and thence to the lower edge of the Great Lakes.

(5) The southern pine forests.

(6) The Western Mississippi Valley and Rocky Mountain forests.

(7) The Pacific Slope forests.

The first region gives white pine, spruce and hemlock as the three principal woods. The same is true for the second area. Hemlock, spruce and diminishing amounts of white pine are given by the third region. Oak, chestnut and hickory are the leading woods obtained in the fourth area. Tulip, poplar and black walnut are also obtained there. Memphis is the greatest hardwood market in the world and draws its supplies from this district. Hard pine is the principal wood got from the fifth district. The cut amounts to 35% of all the lumber cut in the United States. A large export trade in this wood is carried on from Mobile, Pensacola, Brunswick, Savannah, Charleston, New Berne and Norfolk.

Cypress is a valuable water-resisting wood obtained from this area. The new town of Gulfport in Missouri claims to be the greatest lumber shipping point in the world.

From the sixth district the yield is small and is valuable chiefly as a local supply in an otherwise timberless region.

The seventh district is considered to be the finest forest district in the world. Here grow the famous big trees of California, yielding as much as five million board feet to the acre. Commercially, however, these big trees are not so important as the stands of redwood, Oregon pine or Douglas fir. These woods are exported all over the world. Sailing vessels from Seattle, Tacoma, Eureka, Humboldt, and Portland, carry this excellent timber to South America, South Africa, Australia, Japan, England, France, and Germany. This region, of course, continues up into British Columbia, and great quantities of timber are shipped from Vancouver and Victoria. In the United States, Washington is the leading state in lumber production, followed closely by Louisiana. Mississippi and Oregon come third and fourth.

The Russian Forests. Russia has the third largest forest reserves in the world. Many of these areas are as yet not exploited owing to the backwardness of the transportation systems of the country. The areas tributary to the Baltic Sea, however, have important timber exports. The same is true of the area around the White Sea.

Other European Supplies. Large quantities of valuable timber are shipped annually from Norway, Sweden, Latvia, Esthonia, Lithuania and Poland, through the Baltic into Great Britain. These countries also send large amounts to South America, South Africa and Australia.

Western Austria exports a considerable amount of oak obtained from the slopes of the eastern Alps. Czecho-Slovakia is also an important lumbering country.

In the Southern Hemisphere. The lands suitable for forest growth in the southern hemisphere are of small extent and their export trade in lumber is therefore small. The Australian woods are obtained from the coastal highlands and from Tasmania. Ironbark and eucalyptus are important, and the extremely hard Jarrah and Karri pine are woods characteristic of Western Australia. These two latter woods are especially valuable for railroad ties in those tropical regions subject to the ravages of the termite or white ant. These woods are apparently the only ones capable of resisting the iron jaws of these insects. New Zealand is noted for a pine known as "Kauri." This must not be confused with the Australian "Karri." Other valuable trees are found in New Zealand, but reckless felling has seriously depleted the supply, and there is little available for export at the present time.

211. Products of the Tropical Forests. The chief tropical forests of the world occur in Central America, the Amazon and Orinoco Basins of South America, West Africa, the Congo, India, Burma, the Malay Peninsula, and the East Indian Archipelago.

Tropical forests contain many very valuable and beautiful woods, but they are, taken on the whole, much less valuable sources of lumber supply than the temperate forests. There are several reasons for this, of which some are:

(1) The hardness of the trees of the best sorts, which makes them unsuitable for many purposes.

(2) The spotty stands, the trees being usually dotted in small groups over large areas of otherwise worthless timber. Solid stands of one or two kinds of trees such as we know are practically unknown.

(3) The swampy nature of the ground and the rankness of the vegetation, together with the general unhealthiness of these regions prevent large-scale operations.

(4) The crooked growth of most of these trees prevents their being used for anything but decorative work or furniture-making.

Mahogany is the most important wood exported from the tropics. The best comes from Haiti. British Honduras and Cuban mahogany are much inferior. Like most tropical trees, it grows singly in the forest. The mahogany-seeker climbs one tree and looks across the top of the forest until he spots another. He then has to chop his way to it. It can, therefore, readily be understood why mahogany is such an expensive wood. African mahogany is a different species from the Central American

variety. This is exported in large quantities from all coast ports between Senegambia and Kamerun. Liverpool is the entrepot for this wood.

Cedar is the second most important commercial wood obtained from the tropics. It is chiefly obtained from the West Indies, and the Caribbean or Gulf coasts of Central America and Mexico. It is chiefly used for making pencils and cigar boxes.

Teak is the third of the tropical woods in importance. It is a wood closely resembling oak in many ways. It is especially valuable in shipbuilding since it contains an oily substance which preserves it from dry rot. Its native home is the forests of South-Eastern Asia. The chief supply comes from Burma and Siam. In Burma it is floated down the Irrawaddy river to the port of Rangoon, and down the Salween river to Moulmein. In Siam it is floated down the Menam river to Bangkok. Great Britain uses most of the teak produced.

It must be remembered that the most valuable products of the southern forests are such things as rattans, canes, gums, rubber, gutta percha, and nuts, rather than lumber.

212. Pulp and Paper. Paper is made by matting fibres. The fibres used in modern paper-making are chiefly vegetable fibres. Up to 1870 most of the world's paper was made from rags. Today certain types of high grade paper are still made from rags, but the great bulk of the paper now in use is made from wood pulp. Much paper is made from esparto grass, and the very strong paper used for making bank notes is made from the fibres of the bark of the baobab tree. The Chinese make a paper from the straw of the rice plant. The so-called "rice paper" of commerce is made from the pith of a plant grown in the island of Tai-wan. Wood pulp, however, is today the chief source of the paper of commerce.

There are two methods of producing wood pulp. One is known as the mechanical method. By this method the logs are first barked and the knots removed. Then they are sawn into short lengths and pressed against rapidly revolving grindstones which break down the structure of the wood.

The second method is a chemical one. In making chemical pulp there are three processes in general use, called, respectively, the sulphite, the soda, and the sulphate processes. In each of these processes the structure of the wood is broken down by the action of chemicals. The resulting pulp is converted into paper, wall board and also pressed into various shapes, so as to produce such useful articles as tubs, pails, containers, etc. It is also converted into artificial silk. The manufacture of pulp and paper is Canada's second largest industry. The rapid depletion of the American pulp wood supply is the main cause of Canada's leading position as a producer of wood pulp. There seems to be little doubt but that Canada will take the leading

position in this industry. It is a well known fact that no other region in the world has such extensive resources of untouched pulp wood as are to be found in the Dominion.

The largest consumer of paper in the world is the United States. After her comes Great Britain. Most of the European countries, except Spain and Russia, are exporters of paper. Germany is the greatest manufacturer of rag paper. She also makes great quantities of paper from esparto grass. Spain exports huge quantities of this grass to both Germany and Great Britain and buys it back again as manufactured paper, an eloquest testimony to the backward state of industry among the Spaniards. Norway and Sweden export large amounts of wood pulp and newsprint to Great Britain and other European paper-making countries.

Newfoundland has practically ceased exporting lumber and is now a great wood pulp exporting country. Much of the Newfoundland product goes to Great Britain, there to be made into paper.

The great bulk of the Canadian wood pulp is sold to the United States, the value of its purchases in Canada approximating one hundred and twenty-five million dollars annually. Much of this pulp is used to make newsprint paper and book-paper, which the Americans send to almost every European country, as well as Central and South America. It is a sad commentary on the enterprise of the Canadian paper manufacturers that they allow their competitors in the United States to reap the higher profit of the finished materials, whilst Canadians are content to be the producers of the relatively low-priced raw materials. There is not a single valid reason why Canada should not capture this lucrative trade. Canada has the principal supply of raw materials. Her water supply is as suitable for the generation of power as that of the United States. And, finally, she is almost as favorably placed as the United States on the great ocean trade routes of the world.

CANADA'S PULPWOOD RESOURCES (in cords).

	Unalienated.	Leased or Licensed.	Privately Owned.
Nova Scotia	322,000	3,946,000	25,632,000
New Brunswick	537,600	18,027,000	19,108,046
Quebec	146,920,000	178,000,000	20,230,000
Ontario	118,986,700	75,110,000	13,753,300
Manitoba	65,725,090	3,671,373	2,453,537
Saskatchewan	143,330,000	7,070,000	5,150,000
Alberta	261,347,000	7,277,000	6,376,000
British Columbia	126,500,000	149,029,000	19,529,000
Totals	863,668,390	442,130,373	112,231,883

Pulpwood Consumption, 1923, in Canada: Production, $57,119,596; manufacture, $43,594,592; export, $13,525,004. Over 4,000,000 cords of pulpwood are cut annually, and the equivalent of about 4,500,000 cords of pulpwood species are used for other purposes.

Sales to United States. Value of pulp and paper products sent by Canada to the United States approximates $125,000,000 a year.

Future Production. With installation of several new newsprint machines during the past few years, Canada's newsprint production will probably exceed that of the United States in the near future, making Canada the world's greatest producer of newsprint paper—1923 production of 1,251,541 tons was a record.

Production. 110 mills, 2,475,904 tons of pulp, valued at $99,073,203; 1,589,303 tons of paper, valued at $128,086,609; total gross value, $227,162,812; increase of $35,128,448 over 1920. Total pulpwood consumption, 4,654,662 cords, of which 3,270,433 cords, or 70%, were used in pulp mills, and 1,384,230 cords, or 30%, cut for export.

Pulp and Paper Industry. Ranks second in annual revenue. Exports of pulp and paper products, 1923, $140,798,453, chiefly to United States, including 1,137,962 tons of newsprint. Newsprint mills have capacity of 4,400 tons of paper daily. Combined output represents daily cut of 6,000 acres of forest land.

Mills. 1923: 110, viz., 43 pulp, 32 pulp and paper, 35 paper. Gross value of production, $227,162,812; capital invested $417,611,678; 29,234 employed; salaries and wages, $38,382,845.

213. Scientific Forestry and Forest Conservation. The great increase in the use of wood, in some form or other, has resulted in the rapid depletion of the forested areas of the world. So acute has the scarcity of timber become in recent years that the attention of science has become focussed on the problem. This has resulted in the development of "scientific forestry." In the great virgin forests of Canada and many other new lands, the older, wasteful methods are still largely employed. Scientific forestry has attained its highest development in Europe. There the forests are strictly administered and nearly all the government sown forests. These are managed by expert foresters and are thinned, cut and replanted under the closest supervision. As a result of these activities the sadly depleted forests of Europe are being conserved and in many countries are being renewed. Germany, France and Sweden are the most progressive nations in this regard. Even in England the beech woods of the Chiltern Hills are being scientifically administered and an important chair-making industry is carried on in the district.

In France the district known as the Landes, near Bordeaux, has during the past hundred years been converted from an area of shifting sand dunes into a profitable pine forest. This forest has recently begun to pay for itself in rosin, tar, pitch, turpentine, etc. These products are obtained from the smaller trees by tapping. This process kills the trees and the trunks are cut and shipped to England to be used as mine props in the English

coal mines. The thinning thus produced favors the growth of the trees allowed to remain. These larger trees are cut under government supervision and the cut-over areas reforested. A valuable lumber industry has thus been established. The sale of the products has paid for the whole original cost of establishing the forests, and is now yielding a large profit each year.

The French government owns and operates six million acres of forests, which under able and careful scientific management yield the nation a clear profit of $1.75 per acre per year, or about ten and a half million dollars per annum in all.

214. Forest Conservation. The conservation of the world's remaining forest reserves is of vital interest to every one.

Forests are valuable for their products, but they are of untold value in many other ways. They conserve the water supplies of a region by retaining the storm and snow waters in the spongy carpet of moss and leaves which covers the soil. They also prevent too rapid evaporation of soil water by providing shade. Forests also prevent the rapid erosion of the soil by flood waters. They also directly affect the rainfall of a region by passing incredible quantities of water into the atmosphere by transpiration. Forested areas around the headwaters of great rivers greatly reduce the danger of sudden floodings in the lower reaches of these rivers. They are also the homes of valuable fur-bearing animals. In fact, so valuable are the forests of a country that it has been said: "No nation can destroy its forests and remain in the first rank of nations." The value of the forests is becoming clearer to farmers, engineers and manufacturers. As a result, people are beginning to insist strongly upon the protection and conservation of the forests. The chief causes of rapid depletion of forests are:

(1) Forest fires; (2) Destruction by insects; (3) Destruction by fungus diseases; (4) Too close cutting; (5) Destruction of trees too small to be of commercial value; (6) Waste of parts not immediately useful to those who are cutting for special purposes. For example, in obtaining bark for tanning, millions of trees are cut each year, the bark removed and the trees allowed to rot or else are burned. A discussion of methods to be pursued in preventing this waste is beyond the scope of geography and belongs to the study of scientific forestry. The commercial value of forests is, however, so great that no opportunity should be lost to drive home the great importance of forest conservation.

Canada is much more alive to the great necessity of forest conservation than is the United States, but we have still much to learn from Germany and France. The Dominion Government maintains a special department for this purpose. It carries on very active publicity campaigns and maintains a splendid forestry service. Notwithstanding these efforts, the annual depletion of the forests of Canada through fire, insect pests and fungus

diseases is a matter of grave concern. The Dominion Government also maintains large areas of forest reserve within which the commercial cutting of timber is strictly prohibited. The largest of these is the Rocky Mountain Forest Reserve in Alberta.

215. Textiles and Clothing. The textile industries are those concerned in the spinning, weaving, knitting or felting of various fibres into cloth, hosiery, lace, cordage, twine, felts, etc.

Of the fibres used five have great importance, viz., Cotton, wool, linen, natural silk and artificial silk. Of these, cotton, wool and linen have already been treated in detail: Cotton in sections 117 to 124; wool in section 170; flax in sections 125 to 127.

216. Silk. This fibre is produced by a large number of insects in making cocoons in which to pass the chrysalis stage of their life history. The silk fibre of commerce is, however, mainly that produced by a moth known as the silk-worm moth. This moth has been domesticated for so long a period by the Chinese that it is not now found in the wild state. It is reared in immense numbers by the Chinese, Japanese, Italians and French. This industry is technically called "sericulture," but is more popularly known as silk cultivation. It is one of those many primary industries which depend not so much upon climatic as upon economic conditions. The labor of collecting the eggs, incubating them, feeding the caterpillars, and collecting and stoving the cocoons to kill the grub, is enormous. It can only be profitably carried on where labor is cheap, abundant, and at the same time highly skilled. It, therefore, only thrives where the labor of women and children is available. Several attempts have been made to introduce silk cultivation into both Great Britain and the United States. They have all been failures, the main reason in every case being economic rather than climatic.

A considerable quantity of "wild silk" is obtained in certain lands. This appears on the market as Tussah, Pongee and Shantung. The moths producing this wild silk are different from the cultivated variety. They are incubated in open hatcheries among groves of mulberry trees. The resultant caterpillars are allowed to pupate amongst the mulberry leaves and the cocoons gathered and stoved. The silk so obtained is coarser than the cultivated variety and is brown in color. It also contains much more wax. This excess of wax renders it difficult to dye, hence we only see the finished silk in a few simple colors. Tussah or Tussore silk is a wild silk obtained from the Tussah moth of North India and Manchuria. Pongee and Shantung are obtained from wild Chinese moths.

The principal silk-rearing countries are China, Japan, Italy, France, Spain, Czecho-Slovakia, Austria, Hungary, Russia, India, and Asia Minor. The first four are the most important. China uses most of the silk she produces. Japan is the greatest

exporter of raw silk. Italy and France produce the finest quality of raw silk. In 1853 the silk-worm industry of France was almost completely wiped out by a disease which appeared among the silk-worms. The industry was saved by the genius of Pasteur, who, under the orders of the French Government, investigated the disease and found a cure.

217. Artificial Silk. By a chemical process, sawdust, wood pulp, cotton waste and linters may be converted into artificial silk. These substances are first made into a jelly, and when this jelly is forced, by air pressure, through very small holes in glass plates into a suitable liquid, the fibre we know as artificial silk is produced. The process was invented in 1884 by Count Chardonnet in France. Since then several improvements and new processes have appeared. Since the war great strides have been made in the industry. In Lancashire the artificial silk industry has assumed very large proportions, utilizing the waste cotton from the spindles of that district. Recently improvements in the dyeing of artificial silks have been made, and the industry is now on a firm basis. It is competing heavily with true silk since it is relatively very cheap. Its lustre is superior to that of real silk, but it is not so strong and does not stand water very well.

218. The main use of textile fibres is to produce woven or knitted goods, lace and cordage. The production of cloth absorbs by far the greater part. The fibre is prepared for these uses by various preparatory processes. Cotton is ginned to remove the seeds, baled, and transported from the plantations to the mills. Here it is pulled, willowed, scutched, carded, combed, slubbed, roved and then spun. All these processes are accomplished by very ingenious and often complicated machinery. Linen is retted, hackled, scutched, combed, sorted, drawn, roved and spun. Silk is prepared by softening the cocoon in warm water, finding the end and reeling. Reeling consists of uniting several cocoon filaments together. It is an important process, and very tedious. Upon its careful accomplishment depends the evenness of the yarn finally produced. The smooth surface of the filament renders it unsuited to spinning. The length of the fibres also obviates the necessity of spinning. The reeled or raw silk must be conditioned. It is next "thrown" and twisted into yarn. If thicker yarn is required it is next doubled and twisted. This may be repeated several times until the desired thickness is obtained. The short ends of the silk, as well as the filament from perforated or otherwise damaged cocoons, forms what is known as "silk waste." These short fibres are washed, boiled with soap, and dried. They are then carded and spun after the same manner as cotton or linen, and yield "spun silk." This is an inferior textile used to produce imitation pongee or wild silk. It is real silk, of course, but the smoothness of the fibre prevents the twisted short threads from holding firmly together.

Wool is prepared by sorting, cleaning, scouring, dyeing, drying, burring, blending and oiling. If woolen yarn is required, it is now picked, carded, drawn and spun. If worsted yarns are to be produced the oiled yarn is picked, carded, gilled, combed, backwashed, finish gilled, drawn, roved and spun. In many parts of the world a fibre called "shoddy" is produced. This is obtained by tearing old clothing and rags into fibres. These are then respun into yarn. The shortage of wool and it consequent expensiveness makes the manufacture of "shoddy" a profitable industry in the crowded lands of Europe where the purchasing power of the people is low. The resulting cloth is fairly strong and warm, but has not the high quality of the original cloth. All of these fibres must next be woven. This is accomplished by looms. The modern loom is a machine so intricate that it appears to be almost human.

After weaving, the cloth is "finished." The finishing processes are of many kinds, and are carried out by many special forms of machines. As examples: Cottons may be mercerized, or given a silky appearance. They are also printed. Canvas and cretonne are weighted with clay to give them a solid appearance. Silks and cottons are often stiffened with starch, dextrin, or blue. Woolens are often "napped" by machinery to give them a rough appearance. They are sometimes "brushed" to produce a smooth, velvety surface.

219. Cloth Manufacturing Centres. Wool-spinning and weaving centres are widely distributed throughout the world. Much woolen cloth is still produced by domestic manufacture in the less advanced regions of Europe and Asia. England is the leading woolen and cotton cloth manufacturing country of the world, Manchester being the centre of the English cotton industry, and Leeds and Bradford of the woolen industry. Paisley is also an important cotton centre. Nottingham manufactures lace, curtains and hosiery. Belfast is the world centre for linen. The British mills produce finer yarns and fabrics than any other. This is due to the humidity of the atmosphere and the skill of the textile workers. The United States is the second largest cotton-spinning country of the world and the largest producer of coarse cotton fabrics such as canvas, calico, etc. The climatic conditions as regards humidity, and the lack of skill of the textile workers, operate strongly against the production of the finest yarns and goods. The principal cotton-manufacturing centres of the United States are Massachusetts, Rhode Island, and Pennsylvania in the north, and the two Carolinas and Georgia in the south. Fall River is the largest cotton-manufacturing town in the United States. New Bedford produces the finest goods.

Other important wool-manufacturing countries are Germany, Belgium, Poland and Czecho-Slovakia. Lodz and Warsaw are

the textile centres of Poland. Prague is the centre for Czecho-Slovakia. Saxony is the principal woolen-manufacturing region of Germany. Verviers is the great Belgian woolen-manufacturing centre. The silk-manufacturing industry centres about Lyons, St. Etienne and Tours in France, and Milan in Italy. In the United States, Paterson, New Jersey, is the leading silk centre. In recent years Japan has introduced modern textile machinery and is now a leading country in silk production and manufacture. These products represent 37% of her total exports. China is also beginning to manufacture silk and cotton by machinery.

220. The Clothing Industry. Before 1850 the manufacture of men's clothing was carried on chiefly in the household and to a much smaller degree by custom tailors. The invention of the sewing machine and the use of electric power to run it has gradually transferred the manufacture of clothing to factories. The industry is passing through a kind of minor industrial revolution, similar to that which occurred in the textile industries 150 years ago. Because of the great demand for ready-made clothing at low prices combined with quick delivery, the slow methods of domestic production and custom tailoring are rapidly disappearing. They are being replaced by the factory, with its superior organization, division of labor, machine processes and standardized large-scale production. The industry appears to have had its origin in the manufacture of sailors' clothing and coarse work clothes following the establishment of the factory system after the Industrial Revolution.

The clothing industry has developed only in cities. The reasons being:

(1) Labor is a large factor.
(2) Transportation of raw materials easy.
(3) The city populations afford the best markets for ready-made goods of all sizes.

In Canada, the industry is mainly centred in Toronto and Montreal. In the United States, New York is still the leading centre, although Chicago, Baltimore, Philadelphia, Rochester, Cleveland and Cincinnati produce great quantities.

The industry obtains its labor supply on the American continent chiefly from recent immigrants, the Jews predominating. Men rather than women and children are chiefly employed in the New York factories. Italian women and girls are largely employed in Philadelphia.

One of the most striking things about this industry is the rapidity with which specialization, advertising and organization have changed the habits of the civilized nations in respect to wearing ready-made clothing. In 1860 the value of ready-to-wear clothing in the United States was estimated at about eighty million dollars. In 1919 it was stated to have reached a value of

one billion, one hundred and sixty millions. The manufacture of women's ready-to-wear clothing is a later development, but it has been quite as rapid. Before 1880 it was confined almost solely to the production of outer garments. In that year the factories produced only thirty-two million dollars' worth of finished goods. In 1919 the production attained a value of $1,208,000,000. There are no authentic figures available to show the growth of the Canadian clothing industry, but in 1921 the value of men's factory-made clothing is given by the Canadian Bureau of Statistics as $43,766,569; that of women's factory clothing as $35,256,026.

221. Leather and Leather Products. The use of the hides and skins of animals is almost as old as the human race itself, these being man's first clothing materials. Their perishable nature very early led to the discovery of methods for preserving them and rendering them soft and pliable. We, therefore, find that the making of leather is one of the oldest industries. Trade in leather and its products, or else in the raw materials for its manufacture, dates back to the remotest times.

Today the usefulness of leather and the great variety of its products still make it one of the major items of commerce between all nations.

Nearly every country produces some leather for home consumption. This is possible because leather can be made from the skins of a great many animals. Commercial leathers come principally from the skins of cattle, sheep and goats. Specialty leathers are prepared from the skins of the horse, pig, alligator, wolf, walrus, shark, monkey, and many other animals. Some of the more important uses of leather are to make shoes, belting for machinery, harness and saddlery, gloves, coats, travelling bags, purses, novelties and bindings for books.

222. Classification of Pelts. The skins of animals with the hair still on them are known in the trade as "pelts." These are received by the tanner in three conditions:

(1) Green, that is, fresh from the animal.
(2) Salted. When salt has been rubbed on the flesh side to arrest putrefaction.
(3) Dried. When they have been scraped free of fat, stretched on boards or frames, and dried in the sun.

All such pelts are further divided according to size into three general classes, viz.:

(1) Hides. These are pelts of large and fully grown animals like the cow, horse, or walrus. They are the source of the thick heavy leather used for shoe soles, belting, harness and such purposes, where stiffness and wearing quality, rather than softness or richness of appearance, are required.

(2) Kips. Kips are the undersized hides obtained from immature animals.

(3) Skins. These are obtained from small animals like sheep and goats. In the case of calves the pelt of an animal under one year old is termed a skin.

Kips and skins produce lighter leathers than hides. These leathers are used for a great variety of purposes, such as shoe uppers, pocketbooks, book bindings, gloves and fancy goods. Sometimes hides or skins are split, forming thin leathers which are used for shoe uppers, bags, straps, and upholstering for automobiles, carriages, furniture, etc.

223. Sources of Hides and Skins. The great animal-raising regions are, of course, the main sources of supply. For cow-hides, the United States, Argentina, Uruguay, Australia, New Zealand, India and Canada are the main export sources. For sheep-skins, Australia, Argentina, New Zealand, South Africa, United States, Persia and Central Asia. For goat-skins, South Africa, Morocco, Spain, Italy, Switzerland, Greece, Asia Minor, and India. The goat industry of the Pacific States of the United States is a potential supply.

224. Tanning Materials. The materials largely used in commercial tanning may be classified as (1) vegetable, (2) chemical.

Vegetable Tanning. The active tanning principle in all vegetable tanning materials is "tannin." This is widely distributed and is found in some plants on all the continents in sufficient quantity to be profitably extracted and used for tanning.

The main sources are:

(1) Hemlock bark.
(2) Oak bark.
(3) Chestnut extract.
(4) Quebracho extract.
(5) Mangrove extract.
(6) Myrabolans.
(7) Valonia.
(8) Divi-divi.
(9) Wattle bark.
(10) Willow bark.

Hemlock and oak bark are principally obtained from the United States. It is stated that 800,000 tons of hemlock bark and 400,000 tons of oak bark are cut yearly. The oak bark production has remained about stationary since 1900, but the hemlock bark has declined about one-third during the same period.

Chestnut extract was the first tanning material used to meet the situation of an increased demand for leather and a decline in the supply of tanning materials. It is a liquid and about half a million barrels of it are produced annually in the Southern United States. Besides the extract, many Southern United States tanneries use chestnut wood directly.

Quebracho extract is made from quebracho wood. This is a hard wood containing from 18% to 25% of tannin. It is found in the "Gran Chaco" region of the Argentine. The hardness of the wood and the high percentage of tannin it contains renders it a fine wood for railroad ties and also for the production of tanning extract.

The Argentinians are developing the extraction of the tannin as a forest industry. About sixty thousand tons of quebracho extract is exported each year. Its value as a source of tanning material may be seen from the statement that 60,000 tons of quebracho extract are equal to 540,000 tons of oak or hemlock bark.

Mangrove bark is obtained from the mangrove swamps of the coastlands of the tropics, the Gulf of Mexico, the East Coast of Africa, and the East Indies being the principal sources of supply.

Myrabolans. These are the leguminous fruit of an Indian tree. The annual production is about 40,000 tons per year. About two-thirds of this goes to the United States and practically all the balance to Great Britain.

Valonia is the cup of an acorn obtained from Greece and Asia Minor. The production is about 50,000 to 60,000 tons per year.

Divi-divi is a tanning material obtained from Colombia and Central America.

Wattle bark is produced in large quantities in Australia and Natal. It has not yet attained very great importance, but the demand for it is increasing.

Willow bark is used in some countries. It makes a very excellent leather. In former years, Russia was the principal user. The bark itself does not enter seriously into commerce.

Chemical Tanning. Until about 1850, vegetable and oil tanning were the only commercial processes for the manufacture of leather. The terrible depletion of the forests of the world and the resulting rise in the price of tannin-yielding materials caused chemists to turn their attention to the tanning of leather. This resulted in the introduction of the "chromium" method of tanning. Before 1884, little progress had been achieved. At this time Augustus Sheltz patented his "two bath chromium process." In this process the skins or hides are treated with a solution of chromic acid. This is produced by the action of hydrochloric acid on bichromate of potash, or sodium. The

skins are next treated with a solution of sodium thiosulphate (the hypo of photography) and hydrochloric acid.

In 1893, a further advance was made by Martin Dennis, who perfected the "one bath process." This shortened the time required and also the number of baths necessary. Since the introduction of this method "chrome-tanned leathers" have come into great prominence.

Chrome tanning originated in Philadelphia. This has resulted in that city becoming the foremost leather-manufacturing centre of the world.

Canadians should be grateful for this process. It has, without doubt, been a most important factor in saving our forests from destruction, due to the wasteful methods of the bark strippers.

225. Leather-manufacturing Nations. The United States is the leading leather-manufacturing nation in the world. In order to understand why this is so, it must be remembered that (1) she holds an almost complete monopoly of oak and hemlock resources, (2) the chrome-tanning processes are American patents, (3) the large scale of the American packing industry results in a large domestic supply of hides and skins. To supplement these large domestic resources, the United States imports more than a hundred million dollars' worth of hides and skins as well as tannin extracts every year.

Germany is the leading European leather manufacturer, and specializes in colored leathers.

France comes next, her specialty being the lighter skins used for glove-making, etc.

Great Britain is perhaps the greatest worker-up of raw leather into finished goods. The British imports of leather are the greatest of any country, more than a half of the leather produced in the United States going to Great Britain. Besides this, India sends her immense numbers of hides, which are tanned by British tanners.

Spain and Morocco also manufacture some fine leather goods.

226. Modern Shoe-manufacturing. The manufacture of boots and shoes absorbs by far the greatest amount of the leather produced in the world. This industry has undergone rapid changes in method during the last forty years. It was, however, one of the last of the great industries to be revolutionized by the use of machinery.

Until about 1850 all boots and shoes were made by hand. Since that time one labor-saving device after another has been introduced. There are no more wonderful pieces of mechanical ingenuity than modern automatic shoe-making machines. No less than forty-six parts are necessary for making an ordinary shoe and nearly one hundred distinct operations are necessary.

Every one of these is now performed by ingenious machines which cut the leather, stitch the parts, drive the tacks, and do the lasting and the finishing. Even the minutest details of the process are now performed by machinery. The human element is necessary only to assemble the various parts and guide them through the machines. The result is that the workmen employed in a modern shoe factory are specialists in one or two operations. As a rule they know little or nothing about the other operations. The skilled shoemaker of the nineteenth century has almost disappeared. His field is now limited to the making of boots for people with deformed feet or for other highly specialized purposes.

In Great Britain the manufacture of shoes centres around Northampton.

In Canada, Montreal is the principal place of manufacture.

In the United States, Massachusetts leads in shoe production, Lynn and Brockton being the principal towns engaged. Other important New England centres are Haverhill, Boston and Manchester. As boots and shoes are rather bulky to transport, there seems to be a tendency for the modern shoe factory to follow the great centres of population. For example, St. Louis and Cincinnati have become large shoe-making centres in the middle west of the United States.

227. Glove-making is an important industry in France, Belgium, England, Holland and Germany. These regions produce most of the finest quality gloves. The glove-making industry is in sharp contrast to most of the other leather industries in that it is largely concentrated within small areas.

In recent years the United States has entered actively into glove-manufacturing, producing about forty-six million dollars' worth of gloves each year. About one-half of these are produced in two towns: Gloversville and Johnstown.

228. Harness and Saddles. Great Britain is the leading exporter of harness and saddlery. The industry does not seem to be highly concentrated in any particular locality. In Canada the principal centres for the manufacture of these products are Montreal and Toronto.

229. Machinery, Ship-building and Metal Industries. From what has already been said in this book, it should now be clear that the use of machinery has resulted in industrial production being transferred from small-sized, almost domestic concerns to immense factories.

The supplying of the necessary machinery for these large-scale establishments is the function of the machinery industries. For many years the machinery industry was entirely in the hands of the British, whose mechanical genius gave us the steam

engine, the locomotive, and those ingenious textile machines already mentioned under the heading of cotton. The latter part of the nineteenth century saw the rise of two other great machine-making and machine-using countries, viz., Germany and the United States.

In 1910 the position was as follows:

Country—	Export of Machinery
Great Britain	$142,500,000
United States	129,200,000
Germany	119,000,000

The intervention of the war period, with its great changes in the control of sources of raw materials as well as in the general trend of industry, makes the recent statistics unreliable. These do seem, however, to point out that as the world readjusts itself to the new conditions the United States will be the leading manufacturer of machinery, with Great Britain, France and Germany following in the order given. The United States apparently is the most favorably situated nation in this respect, largely owing to:

(1) Abundance and variety of natural resources of the raw materials of industry.
(2) Higher priced labor, which necessitates the extensive use of machines wherever possible.

230. The Machine Tool is, in the words of Professor Russell Smith, "the keystone of machinery manufacture." The development of this industry is largely due to American engineers. It was literally forced upon them by the necessity of obtaining increased output and low cost production with a labor supply commanding the highest scale of wages in the world. These important labor-saving tools, often quite automatic in action, are sent by the Americans to all parts of the world. It is an industry which is not concentrated in any main centre, each type of manufacturing district seemingly producing its own particular variety of machine tool. The industry commenced in the New England states, but with the trend of manufacturing towards the West, the State of Ohio has taken the lead, the principal reasons being that this state is in a region of great iron and steel production and is very central. Ohio has also excellent transportation to all manufacturing regions of the continent by river, lake and rail. Cincinnati and Cleveland are the chief machine tool-making cities. Philadelphia is also a big centre, especially for textile machinery, locomotives and machinery used in ship-building.

In Great Britain, the great towns of Lancashire are chiefly engaged in textile machinery manufactures, in which respect they easily lead the world. Much of the machinery used in the textile mills of America is made in Lancashire.

Germany leads the world in the manufacture of engines. This is largely due to the high value placed by the Germans on science and also to the fact that Germany is relatively poor in supplies of good fuel. This scarcity of fuel necessitates economical methods of power generation. Germany exports more engines than Great Britain and the United States together. Sewing machines are important machine tools. They are largely made by all the "big three" machine-making nations, but the United States easily out-distances the other two.

231. Agricultural Machinery. Since the invention of the binder by McCormick, the United States has rapidly come to the front in the manufacture of agricultural machinery. Today American agricultural machinery is found in almost every country of the world. The lightness of the American product and its comparative cheapness have placed the United States far in the van in this industry.

In addition to its own huge home consumption of farm machines, the United States sends large quantities of farm machinery to Argentina, Canada, Russia and Great Britain.

Canada has a very considerable industry in agricultural machinery. In 1923 there were 73 establishments which produced machinery to the value of $18,240,381. This was not sufficient, however, to completely satisfy the domestic requirements of the Dominion, as farm implements to the value of $8,423,995 were imported during that year.

The Australians have developed a large farm machine industry around Sydney and Newcastle. They were the originators of the "header," a machine which cuts off the heads of the grain and threshes them at the same time. This type of machine was the result of the climatic conditions of Australia. There the wheat is allowed to dry on the stalk, obviating the necessity for stooking. The Australians compete in the Argentine with the Americans in harvesting machinery, largely machines of this type.

232. Automobiles. This is the most important invention since the steam engine. Probably no other modern invention has done so much to promote social communication and economic efficiency as has the automobile.

The rise of the industry has been spectacular. Automobiles were first commercially made in France about 1890; by 1900 the industry was firmly established in the United States. There the American genius for automatic machine tool design and standardized production effected a truly magical revolution in the automotive industry. In 1922 there were 14,507,588 motor vehicles registered in the world, of which 12,239,114 were registered in the United States. This means that Americans owned about 84% of the world's registered motor vehicles. There was on an average one motor vehicle for every 8.6 persons in the country.

The Industry in the United States. In 1895 there were 300 motor vehicles produced in the United States; in 1922 there were 2,659,064, the wholesale value of which was estimated at $1,789,638,365. The automobile industry ranks third in value among the industries of the United States. The industry is chiefly centred around Detroit.

The Industry in Europe. Here, again, the rise of the industry has been spectacular, but upon a less gigantic scale. This is largely due to the great difference in the purchasing power of the middle and working classes of the two continents. The European manufacturer, not being called upon to produce a relatively cheap auto, specializes in the production of individually distinctive cars for those who can afford them. This fact and the better roads of Europe has resulted in the evolution of a somewhat different type of machine.

The Industry in Canada. Most of the autos manufactured in Canada have American chassis and engines which are assembled in Canada and fitted with bodies by the old Canadian carriage firms. Canadians are the second largest users of autos in the world in point of cars owned per capita.

The Canadian industry was established on the Canadian side of the Detroit river, Windsor, Walkerville, Sandwich and Ford City being the most important centres. Of recent years the industry has been gradually shifting towards Toronto. Today the Toronto area rivals in importance the older established centre on the Detroit river.

The automobile industry of Canada has resulted in an increase of the population of certain towns and the springing up of an entirely new city, viz., Ford City.

233. Electrical Machinery. The leading countries engaged in manufacturing electrical machinery are the United States, Great Britain, Germany and Italy. The most outstanding event in the history of electricity was undoubtedly Michael Faraday's discovery of the induced current. This epoch-making discovery in 1831 gave us the dynamo. Following this came the application of the turbine generator which linked up water powers with the production of electricity. This combination ushered in the large-scale use of electricity as a source of power for industrial purposes.

The American manufacture of electrical machinery is mainly centred around Schenectady, Buffalo, Pittsburgh and New York. In Great Britain, Salford and Oldham, great manufacturing towns near Manchester, have large electrical machinery factories. Germany is the leading maker of electrical mining machinery, especially electrical winding engines for mines. Milan is the electrical centre of Italy. In Canada, the development of the hydro-electric idea in Ontario has led to the development of electrical machinery manufacturing in Ontario. The main centres

are at Peterborough, Brantford, Brockville, Niagara Falls, Preston, Hamilton and Guelph. In the year 1922 Canada had 101 establishments engaged in manufacturing electrical machinery and supplies. They produced $41,208,368 worth of finished materials.

234. Carriages and Wagons. Since the introduction of the automobile and the auto truck, the use of carriages and wagons in cities has steadily decreased. By far the largest proportion of these vehicles is now used on the farms and for rural transportation. Even there the good roads movement and the speediness and convenience of the motor vehicle are steadily forcing the carriage out of existence. The wagon, however, still remains supreme on the farm. It is rather hard to see how, for some time at least, the motor truck can replace the wagon for actual farm work.

The bulkiness of the finished carriage or wagon is a factor in determining the location of the industry. Wagon factories tend to migrate to points which are near centres of supply of the raw material (wood and iron), and which are near to well-settled farming regions—the one great market for carriages and wagons.

During the past forty years or so this industry also has become centralized in great factories. This has been made possible by the invention of automatic wood-working machines. The old method of production, by country blacksmith and wheelwright, has now practically disappeared. The greatest users of carriages and wagons are the farmers of the United States and the Russians. The United States is by far the largest producer, its factories not only supplying the domestic needs but exporting largely to Argentina, South Africa and Australia. Canada, a few years ago, had a very thriving carriage industry, but the introduction of automobile manufacture into Ontario has resulted in many of the larger establishments being converted into factories for the manufacture of automobile bodies. The wagon industry, however, is still an important industry in Ontario.

In the United States, Ohio, Indiana, Illinois, Michigan, Missouri and Wisconsin are the leading states. They manufacture more than half the total of carriages and wagons made in the United States. Cincinnati is the leading city for the manufacture of wagons, South Bend and St. Louis ranking second and third. Chicago and Moline are also important wagon-building centres.

235. Locomotives. The manufacture of locomotives is an important industry. It is, however, an industry greatly subject to violent fluctuations between periods of heavy production and periods of almost no production at all. The industry was first developed in the north of England, for many years Great Britain being the sole manufacturer of locomotives. But today the first position in this industry is occupied by the United States. The

reasons for this change of leadership are many, but the most important are the great difference in size between the two countries, the great length of the American railroads, and the rapid settling up of a rich hinterland favoring the large-scale production of transportative machinery. The city of Philadelphia leads all the world in the manufacture of locomotives for all types of work. A single concern of that city manufactures about one-third of the total locomotives made in the United States.

In Canada the two great transcontinental railroads require a large production of locomotives. They are made in the shops of railroad companies. The important shops are at Montreal, Moncton, Winnipeg and Calgary. Canada has no important export trade in locomotives.

In Great Britain, Newcastle and Darlington in the north, Wolverhampton and Birmingham in the midlands, and Glasgow in Scotland, are the great centres for the manufacture of locomotives for export. The great railroad companies also maintain great locomotive-building shops at various strategic points on their lines. Crewe, York, Derby and Swindon are the chief points for the English companies, and Glasgow for the Scottish lines.

In France the industry is located mainly in the north. Lille, Douai, Maubeuge are important centres for this industry.

The Germans make large numbers of locomotives which they send to South America, South Africa and Asia, as well as to many Central European countries. The industry is mainly centred around Essen and Frankfurt. The little country of Belgium has important exports of locomotives, principally to Central Africa. Liege, Charleroi, and Mons are the principal towns engaged.

236. Railway Cars. The manufacture of these important means of transportation gives rise to industry which provides employment for a vast army of workers. The great railroad companies of the four big manufacturing nations all maintain large plants for the manufacture of their own rolling stock. In addition, they purchase large amounts from independent concerns. The railroads of the newer and non-industrial countries are the chief market for the products of these independent companies.

In Canada the private shops of the railroad companies supply most of the Canadian requirements, Montreal, Transcona (Winnipeg), and Calgary being the principal centres. At Preston, Ontario, there is an important car-building industry, the products of which are shipped to several of the British Dominions. This centre is especially noted for street car manufactures. The manufacture of railroad cars in the United States is chiefly centred in Illinois, Chicago having at its suburb of Pullman, perhaps, the largest car factory in the world. Here are manufactured the well-known Pullman sleeping and dining cars.

The wooden car is rapidly being displaced by the much safer steel car. This change is having a tendency to change the centre of car-making from the wood belts to the iron belts.

Pittsburgh is the leading steel car manufacturing city. St. Louis has large car-building factories, its output of street cars being second only to that of Philadelphia.

237. Hardware and Small Metal Goods. This industry is concerned with the production of an almost endless variety of finished goods. They range from such simple but useful things as pins, needles, and cooking utensils up through tradesmen's tools to objects of art, jewelry, watches and clocks. The manufacture of small firearms and their ammunition also comes under this heading.

In all of these industries the actual amount of metal or other material used is relatively small, but the amount of labor required is very large. In many cases, as, for instance, in the production of fine tools and watches, a high degree of mechanical skill and often great artistic ability are called for.

In Canada these industries are principally located around Montreal and South-Eastern Ontario. Here the development of hydro-electric power and the high density of population (for Canada) favor their growth. In the United States, New England holds the lead in the highest grades of tools, watches and clocks. Philadelphia is famous for its saws. Providence, Rhode Island, is the centre of the jewelry trade of the United States. In the production of the cheaper classes of watches and clocks the United States and Switzerland are great rivals. The Swiss hold their own by their cheap but highly efficient labor, and the United States by the adoption of automatic machinery and standardization of parts. Geneva is the leading Swiss centre for watch-making. Cleveland is the leading United States centre for the manufacture of motorcycles. In Great Britain, Coventry is the leading town. British-made motorcycles are the best in the world. This is largely due to the splendid roads and low purchasing power of the people. This latter factor prevents them from using the automobile to anything like the same extent as the people of Canada and the United States. The motorcycle industry of Great Britain is, therefore, relatively more important to Great Britain than is the automobile industry. Coventry and Birmingham lead the world in motorcycle production. The European jewelry and notion industry centres around Birmingham in Great Britain, and Pforzheim and Hanau in Germany.

Cutlery is made in Sheffield in England, Solingen in Germany, and New Haven in the United States. In Canada Niagara Falls and the cities receiving hydro-electric power from Niagara have thriving cutlery manufactures. In small arms, Springfield is the leading American producer.

Birmingham in England, Charleroi in Belgium, and Essen in Germany are the principal manufacturers of small metal

goods. Czecho-Slovakia is the inheritor of the Austrian production of pre-war days. This new country is very active in the manufacture of cheap jewelry and toys. The abundance of extremely cheap labor and of high artistic and mechanical ability in Japan is resulting in that country cutting very largely into the business of European and American manufacturers of small metal goods. This is especially so with respect to China and the other great markets of the Far East.

238. Ship-building. This is the most complex of all the industries. The modern ship is man's crowning achievement. Its building requires the employment of mechanics skilled in more than thirty distinct trades. In addition, it requires the assistance of an army of unskilled workers. Then, besides these workers directly concerned in the actual building of the ship, there must be considered the various correlated industries and trades which provide the materials used in ship-building. Since the natural element of the ship is the water the ship-building industry quite naturally concentrates about suitable points on the waterways, the great size of the ship rendering transport of the finished object overland impossible. The ship-building industry, then, must of necessity be a highly concentrated industry centring around a few extremely favorable localities.

The location of these industries is determined by several factors. These are:

(1) The ship must be built where it can be easily put into the water.

(2) The shipyard must be on or near to a great coal or iron field, preferably both.

(3) It must be so situated with respect to transportation facilities that the large variety of raw materials required may be easily and cheaply assembled.

(4) It must be situated near a great iron and steel and machine-manufacturing centre, since when built and launched the ship must be engined and otherwise fitted.

(5) It must be located near large centres of population in order to obtain the necessary supply of skilled and unskilled labor.

(6) The shipyard must be in a sheltered position and one easily defended. This is necessary so that storms may not delay the progress of the work, nor an enemy in time of war, cause what might be irreparable damage.

(7) In the case of ocean-going vessels, fresh water is preferable to salt water, because it is not so injurious to the steel plates of the hull.

The above factors all combine to force the ship-building yards of the world into a few centres in the various great ship-building countries.

The principal raw materials used in ship-building are steel and iron for the frame work, hull, and machinery; copper, zinc, lead, and phosphorus for the fittings of brass and bronze; various types of lumber, especially teak, oak and pine, for the main constructional woodwork; fancy woods such as walnut, maple, mahogany, ebony, etc., for the finishings; many kinds of gums, resins ,and pitch for the caulking of seams; and varnishes, greases, oils, waxes and pigments for the lubrication, finishing and painting. Steel ropes, cables and chains are necessary for the rigging and anchors of the vessel. Manilla and hempen fibres are also required in great abundance for a great variety of uses. Then, again, there are the rubber, gutta percha, and other electrical insulators necessary for the electrical machinery and fittings of the ship. In addition, there are hosts of other materials entering into navigating instruments like sextants, compasses, chronometers, etc. These are only a few of the many-sided requirements of the ship-building industry. They are sufficient to show why a ship-building industry must by its very nature be concentrated in relatively few places and in those countries which have attained great mechanical skill. The greatest ship-building industry of the world is that of Great Britain. This is amply proven by the following table from *The Statesman's Year Book, 1925*:

Merchant shipping under construction (in gross tons) on December 31 of the years 1922 - 24 is shown as follows:

Countries—	Dec. 31, 1922	Dec. 31, 1923	Dec. 31, 1924
Great Britain and Ireland	1,469,000	1,395,000	1,173,000
Germany and Danzig	464,000	336,000	379,000
France	188,000	110,000	197,000
Italy	211,000	119,000	155,000
United States	139,000	91,000	58,000
Netherlands	143,000	112,000	125,000
Japan	94,000	63,000	39,000
All others	245,000	218,000	344,000
Total	2,953,000	2,444,000	1,473,000

The above figures distinctly show that the United States shipyards have not been able to maintain their high production of the war period.

In Great Britain, the great shipyards are situated on the estuaries of the Clyde, Tyne, Wear and Tees, and at Barrow-in-Furness and Belfast. If a map is consulted it will be seen that all these centres excepting Belfast are either situated directly on a coal field or in very close proximity to one. Belfast has to import all the materials required. Iron and coal, however ,the two biggest requirements, are supplied from Ardrossan on the Ayrshire coal field, only a short sea journey away.

The Clyde ship-building industry is the main support of a number of towns clustered around the estuary of the river Clyde in Scotland. The principal centres are Renfrew, Clydebank, Port Glasgow, Govan, Greenock, and Dumbarton. The Clyde is

a narrow river which has been widened and deepened by the energetic Scots. The river is so narrow that a ship of large capacity must be launched sideways.

The Tyne ship-building yards are at Wallsend, Elswick, Jarrow, Howden and South Shields. The Wear yards are centred about Sunderland. The Tees yards extend from Stockton down to the river mouth. West Hartlepool and Blyth are also ship-building towns near the Tees. Barrow-in-Furness is the big centre of the Lancashire ship-building industry. Its greatest yard specializes in building and equipping warships. Coal is obtained mainly from the Cumberland coal field and the iron is obtained from the local deposits of iron ore in the Furness district. Limestone for flux is obtained from the Cumbrian mountains. Belfast has two great yards, the largest being situated on Queen's Island. The source of the raw materials has already been indicated. Besides these commercial yards, there are many naval yards at which war vessels are built. The chief naval shipyards are at Chatham, Sheerness, Portsmouth, Devonport, Pembroke and Rosyth. The ship-building industry is also concerned with the repairing as well as the building of ships. For this purpose all the major British ports are well equipped with dry or floating docks, foundries and machine shops. Many factors have contributed to the long-established supremacy of the British in the ship-building industry. Some of them are:

(1) The favorable position of the coal and iron fields both as regards proximity to each other and nearness to the sea.
(2) The early realization of the value of iron and the steam engine for navigation.
(3) The skill of the workers and consequent excellence of the product.
(4) The enormous overseas trade of Britain, which requires many ships.
(5) The advantage of an early start.

Other European Ship-building Centres—

In the days of wooden ships, the Norwegians were great ship-builders. The rise of the iron or steel ship and the lack of coal for smelting has resulted in the Norwegians purchasing the ships largely from Great Britain. At the present time the Germans are the chief rivals of the British in the ship-building industry, as they were prior to the war.

Before the war the German industry was fostered by government subsidies and bounties. The Germans specialized in large passenger ships, and hotly challenged the British supremacy in this regard. In fact the largest ships now afloat, the Majestic, the Berengaria, and the Leviathan, are German-built ships. They were handed over to Britain and the United States as part of the reparations exacted of Germany for submarine depredations during the war. It is hardly likely that the building of

such huge vessels will be continued. They are too expensive to build, and the cost of driving them at high speed is too great. There seems to be a tendency to revert to the British ideal of ships having large cargo capacity and moderate speed. The chief German ship-building yards are at Bremen, Stettin, and Kiel. Danzig was formerly a German ship-building centre, but the League of Nations now administers this port as a "free port." The industry in Danzig is, however, still essentially German in capital invested, labor, and ideals. It is, therefore, usually regarded as German for statistical purposes.

France has the third largest ship-building industry in the world. The French industry is only about half the size of the German and about one-sixth that of the British. It is centred at Marseilles, Havre, and Bordeaux.

Italy has important ship-building centres at Genoa, Naples, and Venice.

Holland, Belgium, and, in normal times, *Russia,* also engage in ship-building on a rather extensive scale.

North American Ship-building. In the days of wooden vessels, the finest ships in the world were built in North America. They were mainly built in Nova Scotia, New Brunswick, and New England. But the advent of the steam-driven ship and the iron hull spelled the ruin of this industry and resulted in re-establishing the supremacy of the British in the building of ships.

In the *United States,* the Delaware river is the most important ship-building centre for ocean-going vessels. There are yards at Philadelphia, Camden, Chester, and Wilmington. Baltimore and Newport News are important centres on the Chesapeake. Bath, Maine, and Quincy, Mass., have well equipped yards.

The yards around Brooklyn, New Jersey, and New York make this area the largest single ship-building centre of North America. The Great Lakes shipping is all built upon the lakes' shores, Cleveland, Chicago, Detroit, and Buffalo being the leading centres.

The Pacific coast, having no great bodies of iron or coal, is badly off as regards the raw materials for ship-building. Nevertheless, the need for ship repairs has led to the establishment of first-class shipyards at San Francisco, Los Angeles and Seattle. Little in the way of new ships other than vessels of war is built in these yards.

Ship-building in Canada is not an important industry as yet. A start has been made and there are yards at Halifax (Nova Scotia, Lauzon and Montreal (Quebec), Midland and Port Arthur (Ontario), Vancouver and Victoria (British Columbia). During 1922 the total tonnage launched was only 17,012 tons,

and only one large vessel was included, viz., a lake steamer of 7,403 tons, built at Port Arthur. The Canadian shipyards are principally engaged in repair work and the building of coasting craft.

Japan is the only eastern country having a ship-building industry. It is principally centred about Nagasaki. The shipyards of Japan are thoroughly modern, and her navy and mercantile fleet rank with those of the four leading powers of the western world.

Relative Positions of the Leading Ship-building Nations in 1921 and 1922—

In 1921 the six leading ship-building nations were Great Britain, United States, Germany, Holland, Japan and France in the order named.

In 1922 they were Great Britain, Germany, France, Holland, United States and Italy, also in the order named.

The most striking features of world ship-building during 1921, 1922 and 1923 were the remarkable recovery of Germany and the decline of the United States.

239. Chemical Industries. The application of chemistry is essential to modern industry. More and more is it being realized by the nations that the study of industrial chemistry is essential to leadership in manufacturing.

It is to the chemical industries that we look for the dyes for the great textile industries, and for the development of new fibres to meet the ever-increasing demand for more and still more fabrics.

The agricultural industry is appealing to the chemist for fertilizers, insecticides, etc. The iron and steel industries turn to the chemical industries for their acids, alkalies and other materials used to extract metals from the rocks. The rubber manufacturer, the sugar refiner, soap-maker, and in fact everybody engaged in industry now requires the services of the industrial chemist.

240. Sulphuric Acid. This is by far the most important single chemical used in industry. There is scarcely an industry in the world which does not utilize it either directly or indirectly. For the method of manufacture consult either of the text books in chemistry authorized by the Department of Education for Grades XI and XII. It is commonly spoken of as the "basic chemical of industry." Some economists go so far as to say that the manufacturing status of a nation may be gauged from the amount of sulphuric acid it uses. The sulphuric acid plant is almost always part of some other great industry. Every great manufacturing country produces this acid in large quantities. Sulphide, Ontario, is the leading Canadian manufacturing centre. Widnes and St. Helens in Lancashire are the chief

British towns engaged in sulphuric acid production. In Germany, the leading nation in chemical industry, it is produced on a large scale at several points, as, for example, along the Rhine, in the Ruhr, and in Saxony. In the United States, Pennsylvania, New York, New Jersey, Ohio and Illinois produce about 50%to 60% of the national output. Owing to the ease with which it can be made and the difficulty of transporting such corrosive material, sulphuric acid is usually made in the plants where it is to be used. The amount that enters into foreign trade is not at all indicative of its great importance in industry.

241. Soda appears on the market in three forms: sodium carbonate, sodium bi-carbonate and soda wash. It is the most important alkali used in manufacturing. It was formerly made from wood ashes, but when the Napoleonic wars cut France off from her supplies of soda, which were the great forests of North America, Napoleon offered a prize for a method of preparing it from sea water. This prize was won by Le Blanc, who invented the process bearing his name. Until 1863 this was the only process, but in that year Ernest Solvay, a Belgian, invented the Solvay process. This process produces both carbonate and bi-carbonate of soda, whereas Le Blanc's process gave carbonate of soda alone. Solvay sold the British rights of manufacture to two English chemists of Liverpool. They developed the great British alkali industry which uses the salt beds of Northwich in Cheshire. This British alkali industry dominates the world's alkali production.

Canada imported the following amounts in 1924:

	Weight	Value
Soda Ash	4,649,418 lbs.	$ 67,502
Soda Bi-Carbonate	8,707,345 "	171,303
Soda Carbonate	10,093,782 "	156,580

There is no important manufacture of the above products in Canada, there being only one large plant in the salt district of Ontario. Sodium carbonate is made in small amounts by two firms, one in Quebec and the other in British Columbia. Large quantities are imported from the United States.

242. Calcium Carbide. This is a product of the electric furnace. It is formed by fusing a mixture of lime and coke by means of an electric arc. It is an industry which depends on cheap electric power, and is, therefore, found mainly in countries well provided with hydro-electric power. Norway and Sweden are the leading exporters, Switzerland coming second, and the United States third. Canada manufactures it and exports a considerable quantity. The plants in Canada are situated at Welland and Merriton in Ontario and Shawinigan Falls in Quebec.

243. Carborundum is another electric furnace product formed by fusing coke, sand, and hardwood sawdust, to which

a little salt is added. It has extensive use as an abrasive. Shawinigan Falls, in Quebec, and Thorold and Hamilton, in Ontario, are the Canadian centres. It is produced in large quantities on the United States side of Niagara Falls.

244. Nitric Acid is next to sulphuric acid the most important acid used in manufacturing. Sulphuric acid is required for its production. By far the largest amount of nitric acid is produced from Chile saltpetre, a natural nitrate of soda obtained from the desert of Atacama in Chile. One of the most important of its many uses is for the production of high explosives like gun-cotton, nitro-glycerine, dynamite, T.N.T., etc. It is also a basic chemical in the production of motion-picture films, celluloid, French ivory and other similar articles. Some nitric acid is now made by hydro-electric power directly from the atmosphere and from ammonia. Its manufacture is often carried on in conjunction with the lead chamber process of making sulphuric acid. It is a very dangerous acid to transport; hence it is usually produced near the plants using it. There is no commercial nitric acid producing plant in Canada, although several explosive factories manufacture it for use in their plants.

245. Explosives. These must not be looked upon as merely munitions of war. They have an important peace-time value. Without them modern civilization would be badly off. They provide man with a powerful instrument without which he would not have developed his mines, built his railroads, pierced the mighty mountain barriers, tunneled under rivers, or made his great ship canals.

Then, again, the by-products of the manufacture of explosives constitute a multitude of useful articles without which we should find the world a strange place. If the manufacture of modern explosives were to cease, we should have to revert to glass plates for photography. The whole motion picture industry would vanish. Many dyes and drugs of great usefulness could not be produced. The industry requires as raw materials nitrate of soda, nitric acid, sulphuric acid, sulphur and charcoal. Some branches of the industry use the by-products of the coking industry, e.g., picric acid. The industry in high explosives is a result of the great scientific progress made in chemistry during the nineteenth century.

The "big four" nations are all large producers of explosives. Germany is perhaps the leading nation, due largely to her attention to industrial chemistry. Great Britain, the United States and France are not far behind. In Canada there is also considerable industry. The explosives are largely used in coal and metal mining, quarrying, road and railroad work, and land clearing. There are eighteen firms engaged in the industry. Eleven make high explosives for mines, railroads, road work, and stumping. Nine make fireworks, fuses, detonators, and signals. One firm makes small arms ammunition. Because of the great

danger of explosion, these plants are usually erected at considerable distances from centres of population. One of the Canadian plants, for example, is on a small island in the Strait of Georgia. There are explosive factories at Prescott, Drummondville, Vaudreuil, and Windsor Mills in Quebec; at Nobel, Lindsay, and Guelph, in Ontario; and at James Island, Nanaimo and Coquitlam, in British Columbia. In the United States, Wilmington, on the Delaware, is the leading explosive centre.

Birmingham and Glasgow are the leading British centres, the factories being, of course, located some distance from these cities.

246. The Fertilizer Industry. The growing plant must find in the soil the substances from which to obtain the necessary constituents of its food. Some soils are naturally deficient in some of these substances; others have been subjected to such heavy croppings that they have been made deficient. The problem of restoring and maintaining soil fertility is one of the great scientific problems of the day. The solution of this problem is being sought in the manufacture of fertilizing materials. The main difficulty is the problem of supplying to the soil, in sufficient quantities and at cheap enough rates, three main elements, viz., phosphorus, potash, and nitrogen. These three elements are by no means scarce, but they occur in nature in forms which cannot be assimilated by plants. The business of the fertilizer manufacturer is to convert the unsuitable forms into forms that may be used by the plant. In the cases of potash and nitrogen he has brilliantly achieved his task. His position with regard to phosphorus is, however, not so secure.

247. Phosphates. These occur in large quantities in various forms, the chief of which are bones of animals and phosphate rock. The latter is largely composed of the fossil remains of animals. There is also a mineral phosphate called apatite. This mineral is found in Central Ontario and in Pontiac and Ottawa counties in Quebec. Apatite was at one time an important source of phosphatic fertilizer. But the discovery of the phosphate rock deposits of Florida caused the industry to disappear. It was found that apatite was difficult to mine and there was no assurance of a huge supply. The Florida rock, on the other hand, was soft and easy to get, and the deposit was enormous. The United States deposits of phosphate rock are the principal sources of supply for the rest of the world. They are found in Florida, Tennessee, Wyoming, Montana and Idaho. Of these the Florida and Tennessee deposits are the most important. These United States deposits supply the whole needs of their own country and about a million tons for export, chiefly to Europe. There are also important rock phosphate deposits in Tunis, where the French are exploiting them.

Another source of supply for phosphorus is the slag from the basic process of iron smelting. Large quantities of slag are

produced in the European iron and steel smelting centres. Bones are also an important source of phosphorus. They are collected on the Argentine Pampas and from the great packing plants and shipped to the manufacturing centres where they are burned into bone ash and treated with sulphuric acid to form superphosphates.

The phosphate fertilizer industry is very dependent upon cheap transportation. Therefore the plants are almost all situated at points where water transportation is available.

248. Potash. This industry has for years been absolutely controlled by the Germans. This is the direct result of the possession of the remarkable Stassfurt salt beds, for a description of which see the authorized chemistry texts for Alberta schools. The monopoly of the German potash trust has stimulated the search for other sources of potash. The most promising materials found so far are the great kelp beds of the Pacific coast. A possible source of supply is the flue dust of cement mills which contains considerable potash salts. This is now wasted. Some uses of potash are for glass-making, soap manufacture, bleaching, dyeing, etc.

249. Nitrates.—*Natural.* These are the sources of the nitrogen fertilizing materials. They are the most expensive of all the fertilizers. The natural nitrates used in the industries are dried blood, tankage, and the general refuse of the butchers' shops and the packing plants. Dried fish and fish scraps also form important sources of supply. The various cakes obtained after expressing oils from seeds are also used as fertilizers. The great deposit of guano and similar accumulations of bird droppings found on various islands and on dry coasts in the Southern Hemisphere furnish considerable supplies of natural nitrates. These have also a phosphorus content. The supply of guano comes principally from Peru, the west coast of South Africa, the Seychelles and the Falkland Islands.

The great source of supply of the nitrates is, however, the great Atacama Desert of Chile. This desert occupies the northern third of Chile. It contains vast amounts of nitrate of soda, known in commerce as Chile saltpetre. On this desert has arisen, in consequence of these vast deposits, a great industry, the mining and refining of the "caliche" or crude Chile saltpetre. There are about 120 of these nitrate works, which give employment to about 50,000 workmen. The exports have reached a total of three million tons a year. The Chilean Government imposes a tax on these exports which amounts to roughly thirty million dollars a year. It is estimated that the deposits still contain enough nitrate to supply the world for more than two hundred years. A valuable by-product of the saltpetre industry of Chile is iodine. Chilean nitrates dominate the world's supply.

Manufactured Nitrates. In 1900 Sir William Crookes delivered an address to the British Association for the Advancement of Science, in which he called attention to the then supposed early exhaustion of the Chilean nitrate deposits. This resulted in an attempt to manufacture nitrates and nitric acid directly from the nitrogen of the air. Several processes have been invented, all of which depend on the use of cheap hydro-electric power. Norway has led the way in this industry and still produces the greatest amount. Canada has a large plant at Niagara engaged in making cyanamide by the hydro-electric process.

Another valuable nitrogen fertilizer is sulphate of ammonia, a by-product of the coal gas and coking industry. The leading producers are Great Britain, Germany, United States, France, Belgium and Holland. The value of the total production is about half that of the Chilean nitrate industry. The production and use of sulphate of ammonia have greatly increased since the great war.

250. The Soap-making Industry. This is a chemical industry of large proportions. Soap is made by treating fats with soda and potash. The fats used are inedible animal fats, and various vegetable oils such as palm oil, olive oil, oil of sesame, peanut oil, cottonseed oil, cocoanut oil, etc. Marseilles is perhaps the greatest soap and oil port of the world. Liverpool is next in importance. Antwerp and Hamburg are also important centres for the manufacture of soap and candles. The great packing plant industries of the United States and Canada give rise to a large soap-manufacturing industry on the North American continent. This industry, being largely dependent upon animal fats, produces chiefly cheaper soaps. These are sent in great quantities all over the world. Most of the finest toilet soaps used in America are, however, imported, chiefly from Great Britain and France.

251. Coal-tar, Drug, and Dye Industry. Coal-tar is a thick, oily, black liquid obtained as a by-product in the making of gas and coke. Up to the middle of the nineteenth century it was a waste product of almost no value and very difficult of disposal. Its principal uses were for preserving timber, and for making the lampblack used in the manufacture of printers' ink, shoe polish and paint. In 1856 Sir William Perkin discovered the aniline dye known as mauve, which is a coal-tar product. The discovery laid the foundation of the modern industrial use of coal-tar. Today the coal-tar is no longer a waste product of little worth, but is a valuable by-product whose treatment yields a host of explosives, drugs, dyes, timber preservatives, perfumes, etc.

The coal-tar industry originated in England, which country held the lead for some time. But the Germans, by closer attention to scientific research, soon moved into first place. At the

opening of the war the Germans virtually controlled the industry, producing over 90% of the total output. As a result of the war, however, the Germans lost this trade to the allies. Since the war strenuous efforts have been put forth by Britain, the United States, and France to retain and consolidate the position secured during the war. Great Britain is showing great tenacity in this respect and once more there are great dyestuff industries and drug-manufacturing firms clustering around the textile industries of Lancashire and Yorkshire. In the United States also efforts are being made to retain this industry in the teeth of the keen competition of Germany. The end is not yet. At the present time Germany is making headway, and the struggle will be one of great interest. The German industry centres in the Ruhr and the Rhine Valleys; the British industry in Huddersfield, Salford and Widnes; the American industry in Pittsburgh.

252. Mineral Industries—Building Materials. The chief mineral materials used in the building trades are brick, cement, building stones (such as granite, limestone, sandstone, gneiss, slates, and marble), and gypsum. These are all important articles of commerce. The use of these materials in the densely populated manufacturing countries of Europe is enormous. Also on this continent the increasing cost of wood and the heavy fire risk in cities where it is used, are resulting in an ever-increasing use of brick and stone for building purposes.

Bricks. The cheapness of bricks and their great bulk make it impossible to transport them long distances. Therefore the brick-making industry tends to be distributed throughout the different countries. The raw material, clay, is usually obtainable within easy reach of most cities, so that, as the demand for brick arises, it is usually met by local brickyards. Sometimes, however, a peculiar quality of the clay of a region leads to the production of a specialized type of brick which may be sent to great distances. Fire brick, used in the lining of metallurgical furnaces, is an example of this. The finest fireclay bed in the world is that at Stourbridge, in Worcestershire, England. The highly refractory nature of this clay leads to it being sent all over the world as furnace linings, crucibles, and the like. In the United States, Denver has a similar industry and the products are sent all over the world. Then, again, the need for ships' ballast often leads to bricks being sent overseas from an industrial country to an agricultural region which is backward in industrial development. For example, common British bricks are sent to Argentina as ballast in the grain ships. They are used as building material in that country.

The specialized production of "tapestry" brick at Medicine Hat has led to the establishment of a brick-making industry in that city which supplies most of the brick at present being used in this province.

253. Cement. This important building material has been known since the days of the Romans. Today it is perhaps the most widely used material on this continent for large-scale building. The raw materials required are limestone and clay or shale.

In 1923 Canada had ten plants producing cement; four of these were in Ontario, one in Quebec, two in Manitoba, two in Alberta, and one in British Columbia. The total output was valued at $15,064,661. Canada also imports cement from the United States and Great Britain. Her imports are about balanced by her exports, so that the Dominion as a whole is about self-supporting in regard to this commodity. The leading cement regions of the United States are the Lehigh Valley in Pennsylvania, the Shenandoah Valley in Virginia, Georgia, Eastern Tennessee, Pittsburgh, Ohio, New York, Michigan, Illinois, and Kansas.

In Europe, cement is made in most of the principal countries. Great Britain, Belgium, and Germany export large amounts. It is also manufactured in Peru and Chile, Sumatra, Hong Kong, Canton, Tientsin, Manchuria and Japan.

254. Building Stones. These are usually quarried near the neighborhood in which they are to be used. In certain special cases, however, they enter into foreign commerce. When they do so it is nearly always because of—

(1) Some particula rexcellence of the stone, as, for example, beauty of color, markings, etc.; or freedom from flaws and stains, as in the case of statuary marbles.

(2) Ease of access to deep water transport.

Thus exceptionally beautiful marbles and granites are shipped from Italy, Scotland, Norway, Sweden, Czecho-Slovakia, Switzerland, the United States, and Eastern Canada, to many parts of the world for decorative, monumental, and other artistic uses. Granite is exported from Scotland (mainly from Peterhead), Norway, Sweden, Czecho-Slovakia, and Switzerland, in Europe; and the province of Quebec, in Canada. Massachusetts, Maine, Vermont and New Hampshire are the chief producers in the United States.

Marble. This beautiful stone is mainly obtained from two great centres. The most famous district in the world is that of Carrara, near Leghorn, in Italy. Carrara has produced almost all the statuary marble used in the world for several centuries past. The district also produces a great quantity of fine building marble.

The other great centre of the industry is the state of Vermont, in the United States. The quarries here are very efficiently worked and yield very beautiful stone. Fine marble is also obtained from Georgia, Tennessee and Colorado.

Limestone is a very valuable building stone. Most limestone used in Eastern Canada is "Trenton limestone," which is obtained from local quarries.

In Western Canada "Bedford stone," a limestone obtained from Indiana, is mostly used. This stone is in great demand because it can easily be sawn and worked up by mechanical means when first quarried. After exposure to the air it hardens quickly and becomes very durable.

255. Bypsum is an important mineral used in the manufacture of cold water paints (kalsomine, etc.), and plaster of Paris. It is also used as a fertilizer. Paper manufacturers use large amounts as a "loading" material. Canada exports gypsum in large quantities. The principal producing province is Nova Scotia, which mined 341,705 tons in 1923, the value of which was $747,934. Ontario, New Brunswick and Manitoba also have important gypsum mines.

The total Canadian output in 1923 was 578,301 tons with a value of $2,243,000. Of this production 343,098 tons were exported to the United States.

256. Road-making Materials. These comprise blocks of dressed stone, broken stones, gravel, cement, tar ,asphalt, wood blocks, and many other materials. Blocks of dressed stone are extensively used in Europe and in the cities of Canada and the United States for paving purposes. They are often of granite. Road metal, used in making macadamized roads, is always obtained from local supplies. Tar is obtained from the great coking plants subsidiary to iron and steel smelting. Asphalt is mainly obtained from Trinidad and California. The bituminous sands of Alberta are a great potential source of supply for asphalt, as has already been pointed out.

257. Pottery and Porcelain Manufacture.

In Europe. Fine china is manufactured in Meissen in Saxony, and in Berlin, the production of these two centres making Germany the leading porcelain-manufacturing country in the world. France is, however, Germany's chief rival in the production of fine china. Sevres and Limoges are the chief centres. Copenhagen, in Denmark, produces a very highly prized and distinctive type of porcelain. In Great Britain there is a large ceramic industry and the high-grade porcelains produced by the British are prized in all parts of the world. Crown Derby, Royal Worcester and the unique Wedgewood ware are examples of the British porcelains. In pottery English semi-porcelain and heavy pottery are produced in large quantities in the "Potteries," a district of Staffordshire. Much of this is exported to Canada, South Africa and Australia. Formerly it was also exported to the United States, but this part of the trade has declined owing to the establishment of the industry in the States.

Holland is noted for "Delft ware," pottery, and tiles. Italy makes and exports large quantities of "majolica ware," familiar as the form of the dark glazed teapots found in almost every household.

In the United States. The pottery and porcelain industry has greatly increased in the United States in recent years. Trenton, New Jersey, and East Liverpool, Ohio, are the principal centres.

The greater part of the finer pottery and porcelain is still imported, Great Britain, France, and Germany being the principal sources.

In China and Japan. China has for centuries been famed for its porcelain. In fact, the common name for porcelain is "china." The Chinese taught the art to the Japanese, and now the Japanese are as expert as their teachers. Little of the Chinese ware is exported. But most of the modern Japanese product is manufactured for export. This wholesale manufacture of the cheaper grades for export has resulted in a sad deterioration of the quality and individuality of the designs and finish of Japanese work. Thus notwithstanding the large quantity of Japanese porcelain exposed for sale in Canadian stores, the Japanese industry supplies but a small part of the Canadian trade when compared with that of Great Britain, Germany, France, and the United States.

In Canada. The making of pottery in Canada is only in its infancy. The clay beds of Saskatchewan and the supply of natural gas of Southern Alberta are the chief factors which have caused the establishment of ceramic manufactures in Medicine Hat. The chief products are heavy glazed pottery, such as crocks and basins. Majolica ware teapots are also produced. Glazed tiles and drain pipes are other lines made in this new centre.

258. Manufacture of Glass. The American glass industry is the biggest in the world. The chief centres are Southern New Jersey and Eastern Pennsylvania in the east, and Western Pennsylvania, Ohio, and Indiana on the western side of the Appalachians. The Pittsburgh district is the greatest glass-manufacturing district in the United States. The Belgians are also very important manufacturers of glass. The towns situated near the Liege and Charleroi coalfields make most of the window-glass used in Europe.

Germany is, after the United States, the world's largest glass manufacturer. The chief centres are along the Rhine and on the edges of the Saxon and Silesian coalfields. Bavaria and Saxe Weimar are German states famous for the manufacture of scientific glassware used in making lenses and laboratory apparatus. Jena is the principal town for this type of glassware. The French industry is located near the Belgian frontier. French crystal glass is the most important export. It is made at Baccarat.

The British glass industry is the third largest in the world. The chief centres are Bristol, Birmingham, Newcastle, and Liverpool, where an abundant supply of coal is easily accessible.

The most distinctive product of the British glass factories is "plate glass" for store fronts. This is nearly all made at St. Helen's, in Lancashire.

Glass Manufacture in Canada. There are six firms in Canada engaged in making glass. One firm makes certain grades of window glass only. Another restricts its operations to globes, shades and bulbs for electric lamps. The others make bottles, glass sealers, lamp chimneys and bases, and other related products. Their total production only amounts to a mere fraction of Canada's requirements. It would appear that there is scope for a wide extension of the glass industry in the Dominion. There is an important glass factory at Redcliffe, near Medicine Hat.

259. Copper. This important metal is used for a great many purposes. Being such a splendid conductor of electricity, it forms an essential part of nearly all electrical machinery. It is the principal metal used in making alloys—brass, bronze, and German silver all containing it.

It is also used for making boilers, locomotive fire boxes and retorts; for sheathing wooden ships; for the roofs for buildings; for coinage, and copperplate engraving. It is also an ingredient of green paint.

The United States produces more than one-half of the world's copper. Mexico is the next largest producer.

Swansea in Wales is the second largest copper smelting centre of the world, smelting about one-half of the copper ores not treated in the United States.

Anyox in Northern B.C., and Granby and Tail in Southern B.C., are important Canadian centres for copper smelting.

The copper industry of the United States is mainly located in the Lake Superior region; in Montana at Butte, Anaconda, and Great Falls; in Arizona at Besbec, Morenci, Glove and Jerome. Nevada and Utah and Colorado are also copper producing states. The United States also smelts a great deal of copper ore imported from other countries. This ore comes largely from Labrador, Newfoundland, Spain, Germany, Italy, Peru, Cuba and Canada. The cities of New York, Baltimore, and Norfolk are the principal centres for the smelting of foreign ores.

South America has valuable copper deposits on the Pacific coast, the desert region of Northern Chile being one of the most important copper-producing areas of the world. Peru has important copper mines in the Cerro-de-Pasco district. In Africa the copper deposits around Katanga in the Belgian Congo are the most important. These deposits promise to become one of

the world's principal sources of copper. There are also important copper mines in the Northern Transvaal at Messina, at Broken Hill in Rhodesia, and also near Ookiep in Cape Colony.

260. Nickel Industry of Ontario. Canada leads the world in the production of nickel, the output of the Dominion constituting over 80% of the world's supply.

This all comes from the Province of Ontario. It is mined chiefly in the district surrounding the town of Sudbury. This supply is supplemented to a slight extent by the output of the Alexo nickel mine on the outskirts of the Porcupine gold district, and by a much smaller quantity recovered as a by-product of the treatment of the complex silver-cobalt-nickel ores of the Cobalt district.

The present nickel industry of Canada is entirely in the hands of three large corporations, all of which operate in the vicinity of Sudbury. The oldest and largest of these is the International Nickel Company of Canada, with smelters at Copper Cliff and a refining plant producing refined nickel, nickel oxide, and blister copper, at Port Colborne, Ontario. The other two corporations, the Mond Nickel Company, with smelters at Coniston and refining plant at Clyach in Wales ,and the British America Nickel Corporation, with smelters at Nickelton and a refinery at Deschenes, Quebec. These plants are all equipped to produce electrolytic nickel and copper and the precious metals platinum, palladium, gold, etc.

The production of nickel in Canada in 1922 was 17,597,123 pounds as against a maximum production of 92,507,293 pounds in 1918, and an average annual production of 41,472,000 pounds for the four years previous to the war. The decisions of the Disarmament Conference seriously affected, for the time being, the outlook for the nickel industry in Canada, inasmuch as one of the chief uses of nickel was formerly for the manufacture of armour plate, but the development of new, and the extension of former industrial uses of the metal have largely offset any loss of markets on this account.—(Extracted verbatim from *The Mineral Industries of Canada*—Department of Mines, Ottawa ,1924.)

261. The Manufacture of Aluminum. This metal has only come into general use since 1907. This at first sight seems rather strange, since it occurs everywhere in immense quantities as a constituent of ordinary clay. The difficulties of extracting the metal, however, are great. Aluminum was first manufactured commercially about 1860. The price was then $10 per pound, with a total annual production of less than five tons.

In 1907 a young American chemist discovered a method of extracting the metal from its ores by using electricity. As a result the price is now only twenty-seven cents per pound and the production in 1916 had reached the total of 147,640 tons.

The principal producers are those countries possessing hydro-electric power, as cheap electric power is the chief requisite for this industry. The United States, Canada, Germany, Switzerland, Italy, Norway and Japan are the leaders.

The Canadian production is all derived from one plant situated at Shawinigan Falls, Quebec. The ore is all imported. The Canadian production is entirely dependent on cheap power and transportation. In 1921 this single plant exported aluminum in bars, blocks, sheets, etc., to the value of $1,259,703. The Canadian exports of aluminum manufactured goods from eight other factories amounted to an additional $273,401. The total production of aluminum and its products in Canada for 1922 and 1923 together was valued at $3,851,925.

262. Gold. This is one of the most widely distributed of all the metals. It is one of the most ductile and malleable of metals and does not tarnish upon exposure to the air. Its principal use is for coinage and the manufacture of jewelry. It is also used in gold plating.

South Africa is the principal producer, contributing more than 40% of the yearly output. The chief seat of the industry there is at Johannesburg in the Transvaal.

The United States is the second largest producer, whilst Canada has now risen to third place. The principal Canadian contributor is the Province of Ontario, which produces 79% of the Canadian output. British Columbia is a poor second with 15.63%.

Canada possesses in the Hollinger Gold Mine in Ontario the largest gold mine in the world. Canada is the only country in the world whose output of gold is increasing. Australia and Brazil are also important producers of gold.

263. Silver. The principal uses of silver are for coinage, silverware, watch cases, jewelry, and silver plating. It is also used extensively in the manufacture of photographic plates, films, and papers.

The leading producer of silver in the world is Mexico; the United States comes second, and Canada third. Peru, Bolivia, Australia, Chile, Japan, Burma, Germany, Spain, Portugal, Central America and the Dutch East Indies rank, in the order named, as the other important silver-producing countries, all of them together producing more than one million fine ounces of silver per annum. India and China are the great users of silver. Immense quantities are shipped to those countries for use as currency.

264. The Diamond Industry. The diamond industry is divided into two distinct branches, viz., the diamond-mining industry and the diamond-cutting industry. The lead in the diamond-mining industry was formerly held by Brazil, but dur-

ing the latter part of the last century South Africa became the leading producer. This was due to the discovery of the "pipes" of blue ground. These are believed to be the necks of old volcanoes. The diamonds are found imbedded in them.

The chief centre in South Africa is at Kimberley in Cape Colony, although there is another large mine near Pretoria in the Transvaal. It was from this latter mine that the famous "Cullinan" diamond was obtained. This is the largest diamond in the world and weighs just over one pound. In size it is just about large enough to fill an ordinary tea cup. This diamond now forms part of the Crown jewels of the British Empire. It was valued for purposes of taxation at $5,000,000 before being cut.

South Africa has for about the last forty or fifty years enjoyed a monopoly of the diamond production industry.

Recent opening up of the interior of Africa has revealed other fields which may soon challenge the position of South Africa. These are located in what was previously the German colony of German South-West Africa. Other discoveries have been made near Katanga in the Belgian Congo and in Tanganyika Territory. Diamonds have also been discovered recently in British Guiana and in New South Wales.

The diamond-cutting industry is chiefly a European industry. For many years Amsterdam was the principal centre. Antwerp in Belgium and Hanau in Germany have in recent years become important centres.

The greatest purchasers of diamonds are the people of the United States. They purchase more than $40,000,000 worth of diamonds a year.

265. Asbestos and its Uses. Fifty years ago the uses of asbestos were almost nil. Today they are extensive. This is due to two factors: the enormous advance in the use of electricity, and the introduction of the automobile and internal combustion engine. Some of the principal uses are for automobile brake linings, for insulation in flexible electric cords, and for high tension wires, theatre fire curtains, heat insulators for steam pipes and furnaces, gloves and clothing for the furnace operators in the great smelting industries, and many other purposes. The asbestos required in industry amounts to about two hundred thousand tons a year. Quebec furnishes about 85% of this amount. At present Rhodesia is entering the market as a producer of asbestos, and it is believed that Canada's monopoly of the industry will be seriously challenged by the Rhodesian product.

In Canada the most important deposits are at Thetford, Broughton, and Coleraine in the Eastern Townships of Quebec. The Canadian production for 1922 was 163,706 tons, valued at $5,552,723.

266. Lead. Lead is used for making lead pipes and electric storage batteries, and for lining tanks, covering roofs, making

bullets. It is alloyed with other metals to make a number of valuable alloys such as type metal, solder, etc.

It is a constituent of many kinds of glass, and it is used in the form of carbonate of lead to make white paint.

The principal countries producing the metal are the United States, Spain, Germany, Mexico, Australia, Canada and Belgium.

The principal Canadian centres for lead-smelting are Trail, B.C., and Galetta, Ontario. The Trail output for 1923 was valued at nearly eight million dollars. This fine showing was due to the splendid metallurgical work carried out by Canadian-trained metallurgical engineers who are directing the lead and zinc industry in British Columbia.

267. Zinc. The principal use of zinc is to galvanize sheets of iron and iron wire to prevent rusting. These galvanized materials are made into roofing, cornices, tank gutter spouting, water pipes, fencing, barbed wire, wire netting, nails, bolts, screws, and the like.

Zinc alloyed with copper makes the valuable alloy known as brass, and alloyed with copper and tin it forms bronze. It is also burned in air to form oxide of zinc, which is used to make white paint.

The United States produces about 30% of the world's zinc; Belgium about 20%. Canada is also an important world contributor. In 1923 Canada exported zinc to the value of $2,519,073. The principal producing centre is Trail, B.C., where over 60 million pounds of zinc were produced last year. Other countries producing zinc are Germany, Holland, France, Great Britain and Australia.

268. Tin. This was one of the first metals used by man. The tin mines of Cornwall have been worked since the days of the Phoenicians. The principal use of tin is in the making of tinplate. Tinplate is merely sheet iron coated with a thin layer of tin. It is mainly used in the manufacture of containers for canned foods. Tin is alloyed with copper to make bell metal, and with copper and zinc to make bronze. Alloyed with lead it forms pewter.

The principal producer of tin is the Straits Settlements; Bolivia comes second; the Dutch East Indies third; and Cornwall fourth.

269. Mercury or Quicksilver. This is a metal which at ordinary temperatures is a liquid. It has the peculiar property of combining with certain metals to form plastic alloys which are called "amalgams."

The principal uses of mercury are for the extraction of gold and silver from their ores, the construction of barometers and thermometers, and for silvering mirrors.

Some of the compounds are used in medicine and surgery as "calomel" and "corrosive sublimate." Others form valuable pigments. The principal sources of supply are Spain, Italy, the United States, and Hungary.

270. Antimony is a very valuable constituent of type metal, since it is owing to its peculiar property of expanding when cooling that type metal owes its suitability for making sharp casts. Some of its compounds are valuable in medicine. The principal source of supply is China.

271. Platinum is one of the heaviest of metals. Its principal use is for making the leading wires of electric incandescent lamps, X-ray tubes, etc. It is a very valuable metal in all scientific laboratory work. The principal deposits are in the Ural Mountains, whence comes almost all the platinum used in the world. Since the disruption of Russia the output has been very much reduced and the price of platinum is now about $150 per ounce.

272. Special Note of the Manufacture of Metal Goods. The manufacture of metal goods on the large scale now demanded by the world requires all the scientific, mechanical, and organizing ability that can be concentrated upon it. The transportation facilities must also be of the best. The work is arduous and can only be successfully carried on in climates that are especially favorable to the development of energetic peoples.

In consequence we find that the manufacture of metal goods is carried on almost entirely by three nations, viz., the United States, Great Britain and Germany. The United States produces about 4/10 of the world's supply, Great Britain about 3/10, and Germany a little less than 2/10.

It is skill in the metallic arts which has contributed very largely to the supremacy of these nations in the commercial world.

PART III

COMMERCIAL GEOGRAPHY.

273. Land Transportation is carried on in many ways. The routes may be trails, roads, or railroads; and the motive power may be supplied by man, beasts of burden, or by mechanical means such as locomotives and the various kinds of steam and electric engines.

Trails are the simplest form of transportation routes. They follow the natural surface of the country, crossing rivers at convenient fording places and mountains at low passes. The goods are usually transported by men who are known as "porters." When the trail permits, the porters are replaced by sure-footed beasts of burden. In the mountains of Spain, in Mexico, and in the Cordilleran region of North America, the "burro" or donkey, and the mule are used. Llamas are employed in the Andes to carry ores from the mines to the sea coast. The yak is used in Thibet and in the Himalayan passes. A variety of mountain sheep is also used in the Himalayas. On the more easy slopes and in the foothills regions the pack horse is used, largely because the horse can carry a heavier load than the previously mentioned beasts of burden.

In desert regions a special form of transportation known as the "caravan" has been evolved. It is formed by the banding together of travellers for convenience and protection in traversing the deserts of Africa and Asia.

The camel is the usual beast of burden in these deserts, but the horse is sometimes used. The camel is preferred, because it can carry a load of from 800 to 1,000 pounds, and can subsist for long periods of time with little food, and with no water. The maximum load for a horse is 800 lbs., and it must have water and ample food daily. There are two species of camel: the Bactrian or two-humped camel, and the Arabian or single-humped camel. The dromedary is a variety of the Arabian camel, and not a separate species.

The dromedary amongst camels is exactly analogous to the race horse amongst horses. It is simply a well-bred and very fast camel used for speedy communication and racing. A dromedary will travel 100 miles in a day.

In Arctic regions the dog both as a pack animal in summer and a draft animal in winter is used by the natives of the American and Asiatic tundras. In Europe and Asia the reindeer is pressed into service. In Canada and Russia horse-drawn sleighs are important means of transportation during the winter.

Roads and Highways. With use the trails gradually widen out and form the poorer class of roads. With the settling up of a country more and more attention is paid to the roads, both as to construction and maintenance. Soon one road becomes singled out from the others because it leads into some town or other centre of activity, and is kept in especially good repair. This forms a "highway." Its function is to connect the farm roads and other byways with the railroad. The highways are the feeders of the railroad.

Railroads. These are the highest type of land transportation yet evolved. Everyone is familiar with their appearance and manner of construction, so there is no need to describe them here. The railroad takes many forms and its main purpose is to move freight. It is estimated that there are over 600,000 miles of railroad in the world. Of this mileage about one-half is on the North American continent.

Railways may be owned by private corporations, as in Canada, Great Britain, and the United States, or they may be owned by the government.

The Canadian Government now owns the largest trackage controlled by any one agency.

The Commonwealth of Australia and the Union of South Africa are other examples of governments owning and operating their own railroads.

The application of power-driven vehicles to land transportation has been productive of four great results, all of which have been brought about in less than one hundred years. It was not until 1829 that the first commercially successful railway was opened, between Manchester and Liverpool. The four results are:

(1) Greater specialization.
(2) Greater power, speed, endurance, and load-carrying capacity.
(3) Greater danger.
(4) Greater demand for high mental ability among transportation employees.

Specialization. The trend towards specialization is shown by the invention of special modes of transportation, e.g., railways, steamships, automobiles, street cars, airplanes, cash carriers, elevators, dredges, pneumatic mail chutes, and special tank cars for oil.

Speed, Endurance, and Load Capacity. The first railroad engines for commercial transportation were Locomotion No. 1 and Locomotion No. 2, built by George Stephenson and Co. for the Stockton and Darlington Railway, a private road used to carry coal and iron ore between the two towns. These locomotives had a speed of 6 miles per hour. Their carrying capacity was somewhere in the neighborhood of 200 tons. Their endurance, or distance capacity, was 12 miles, this being the distance between Stockton and Darlington.

The American locomotive "Frisco," probably the largest and strongest locomotive at the present time, is capable of moving a load of 2,000 tons up a slope of 15 in 1,000 at a rate of 8 miles an hour, and for a distance of 350 miles without replenishing its water or fuel supply.

Greater Danger. Every new development in transportation is designed to give increased speed, greater carrying capacity, or both. In any event it means the use and control of greater power. The moving of great loads at the speeds demanded by modern industrialism results in many accidents. This tendency to speed things up has enormously increased the number of fatal accidents due to transportation.

Of the 1,412 deaths recorded as due to Industrial accidents in Canada during 1923, 372 or 26.4% were due to transportation accidents, the steam railroad accounting for 168 and water transportation for 100, the remaining 104 being accounted for by street cars, autos, and other similar conveyances.

In 1920 the official figures for fatal accidents due to all forms of transportation in the United States were:

Automobiles	9,103
Railroads	8,491
Street Cars	2,326
Other vehicles, chiefly horse-drawn	2,198
Total	22,118

Demand for High Mentality. Each step forward in transportation demands higher mentality. The most stupid man can carry a load as well as the most intelligent, perhaps better. The locomotive and the steamship demand highly trained men with alert mental faculties for their successful and safe operation. The management of modern transportation systems calls for the highest possible type of mentality.

Pipe Lines. One of the most remarkable means of transportation which has been developed in recent years is the fluid-tight pipes through which different kinds of materials are forced. They are used mainly for transportation of such materials as water, gas, or oil.

In 1900 a pipe line was opened in Southern Russia to transport the crude oil from the wells of Baku to the port of Batum on the Black Sea. Another was opened in 1918 between the Clyde and Forth rivers in Scotland, whose capacity is 100 tons of oil per hour. In the United States there are roughly 20,000 petroleum wells. These are connected with the various refineries and the seaboard by means of thousands of miles of pipe lines. Natural gas is transported hundreds of miles through pipes. There are several of these gas lines at present operating in Alberta. Recently Edmonton has been connected with the gas wells at Viking and is now receiving natural gas through pipes.

But pipe lines are also used for the transfer of other commodities. In London, England, they are used for the transfer of telegraph messages and parcels from the branch offices to the general post office. They are also used in departmental stores for the transfer of cash and parcels.

Mail Routes. These include railways and highways, telephone and telegraph lines, submarine cables, the wireless telegraph and, with the astonishing progress of the last five years, "radio" or wireless telephony.

The whole idea underlying the provision of these facilities is the securing of rapid communication between the various civilized centres of the world with merely nominal charges. One of the most potent factors in the securing of these privileges has been the "postal union." An important aid to rapid communication has been the submarine cable. The North Atlantic is crossed by fifteen of these. They are also in the Mediterranean, and Egypt is the centre from which radiate cables to India, China, the Philippines, Australia and New Zealand.

Cables run from Mexico to Valparaiso on the west coast of America, and completely surround Africa. Submarine cables cross the Pacific from British Columbia via the Fanning Islands, Fiji, and Norfolk Island, where they connect with those of Australia and New Zealand. Another trans-Pacific cable runs from San Francisco to Honolulu, thence to Midway Island, Guam and Manilla. There is also another connecting the United States with Alaska. Telegraph lines are sometimes owned by the government and sometimes by private companies. Government-owned telegraph lines are more usual in Europe than in American countries.

274. Water Transportation. Water transportation is divided into two great divisions, viz., Oceanic navigation and inland navigation. It is carried on by means of the following types of vehicles:

Steamships, sailing ships, motor boats, barges.

Other conveyances operated by man-power, such as row boats, canoes, and rafts.

Oceanic navigation is by far the most important method of transportation today.

With the application of steam power to ships there were realized on the sea the three essentials of any modern system of transportation—cheapness, reliability, and speed.

With this there has slowly arisen a shifting of importance from the land routes to the sea routes in our modern methods of communication. The older geography taught that the oceans were the great barriers to communication between nations. In the modern view this is changed and the ocean is now the great connecting link between nations. Nearly three-quarters of

the surface of the earth is ocean, and over this huge expanse cross the greatest highways of commerce. By far the greater part of the commodities carried from one country to another pass over these great sea routes. Through the centuries ocean-borne commerce has steadily increased, and during the last fifty or sixty years it has made such strides that it has become phenomenal, far greater than the average person dwelling inland thinks. The great reason for this is its cheapness. Transportation by water is the cheapest known method, and ocean transportation the cheapest of all water-borne methods.

The reasons for the low cost of ocean transportation are:

(1) The free highway.
(2) The ready-made road.
(3) No cost for road maintenance.
(4) Freedom from taxation.
(5) Smaller power requirements.
(6) Smaller labor requirements.
(7) Comparatively low costs of ship-building.
(8) Safety.

The Free Highway. The sea is open to all. Anyone who can build a boat may use it. In the case of land transportation, however, the right of way must be purchased, and the annual interest on vast sums of money invested in "right of way" by, say, railroads or canal companies, forms a very serious handicap in fixing the cost of transportation, and at once swings the balance strongly against the railroad.

The Ready-made Road. The ship does not require a track to ride on, while all forms of land transportation require some form of construction. The railroad requires an expensive track of steel, wood, and stone; and may cost anything from $15,000 per mile upwards. Indeed, when the sidings, stations, road-beds, etc., are included, the cost is usually somewhere around $100,000 per mile for construction alone. The interest chargeable on the immense sums locked up in this item alone is a large factor in the cost of railroad transportation.

No Cost for Road Maintenance. Since the sea tracks never wear out, there is no charge for road maintenance on sea-borne freight, but with the railroad it is far otherwise. Tracks are constantly wearing out, rails split, ties decay, sudden storms may cause washouts, and so on. This causes the railway companies to employ large numbers of men as track walkers and section men whose business it is to repair the tracks and keep them in good condition. In a similar manner governments, both national and municipal, are faced with an annual charge for the repair and general maintenance of highways, over and above the first cost of construction. All these charges result in another direct charge on the land-borne commerce which does not apply to oceanic commerce.

Freedom from Taxation. Taxation is another item from which ocean shipping is virtually free, but which is a very serious handicap to the railroads in competing with ocean transportation, even where, as in Canada, the "right of way" may escape all or a portion of the taxation levied upon the other land in its vicinity.

Small Power Requirements. Owing to the difference in the nature of the medium over which the goods are being carried the ocean or water-borne commerce is specially favored in this regard. The levelness of a water surface as against the undulating nature of any road surface means less power expended to move a given load. It is the common experience of everyone that things are easier to move when immersed in water than when they are not, since the buoyant force of the water sustains the weight. It is this buoyancy of the water which makes a boat easier to move than, say, a wagon or a sleigh. Lower power requirements mean less coal and oil cost, and, therefore, cheaper transportation.

Smaller Labor Requirements. This is another point of advantage which the ship has over the railroad. A big freight steamer of, say, 12,000 tons register, can carry about 25,000 tons of freight. Such a ship usually can make about 15 miles per hour steadily day and night. This is equal in speed to the average of fast freight trains when the time taken up in waiting at siding or in the yards is allowed for. To carry 25,000 tons of freight about 20 trains would be required and each train would be composed of about 30 cars, a locomotive and caboose, with a crew of at least five or six men. Three crews are required during each 24 hours. Then, in addition, we must take into account the time given to these trains by station agents, despatchers, flagmen, switchmen, oilers and others, so that we can consider the labor equal in all to about 36 men for each train. This would mean 720 for 20 trains. But such a steamer as we are considering, if used as a freighter, would need only 100 for her crew.

The Comparative Costs of Building Ships and Locomotives. An average locomotive costs about $70,000 and a freight car about $3,500, so that a 30-car train would cost about $175,000, and the 20 trains about $3,000,000.

A 12,000-ton freight steamer, however, costs only about $2,000,000.

Safety. Contrary to popular ideas, water transportation is safer than rail. The proportion of lives lost at sea is far less than on land, notwithstanding such fearful catastrophes as the loss of the *Titanic,* and other disasters of a similar nature.

275. The Requirements of a Modern Harbor. Ocean transportation systems require terminals just as land transportation systems require stations and freight yards. The terminals of an ocean route are called "harbors." These are provided for the ocean carrier by the communities which desire to attract

shipping to their ports. A good harbor, however, must have something behind it other than the desire of the community to become a shipping centre. The requirements of a modern harbor are:

(1) Protection from wind and waves .
(2) Good depth of water.
(3) Sufficient space for the anchoring and manoeuvring of a vessel without damage to herself or other ships.
(4) Plenty of dockage space.
(5) Level land to provide sufficient space for a city.
(6) Easy lines of communication into the interior.
(7) A "Hinterland" or "back country" in which to sell imported products in exchange for raw materials, food, or manufactured goods.

Protection. No shipping dare risk lying at anchor near a coast exposed to the full fury of the weather. Islands and headlands are natural protective features, but they are often supplemented by artificial means like breakwaters, moles ,etc. Seaports spend great sums providing breakwaters and other artificial means to make their harbors safe.

Depth of Harbor. In order to cope with the increased demands of modern trade, ships have become larger, and they consequently require a greater depth of water to float them. Many famous ports of the older days are useless for modern steamers because of their lack of depth. These ports have consequently sunk to a second or even third rate importance and are gradually passing from the notice of modern peoples, except in historical or literary reference. In order to attract the biggest ships of these days a harbor must have from 35 to 40 feet depth of water. Very few great ports have such a depth of water naturally; hence each year millions of dollars are spent by national governments in deepening harbors. The Dominion of Canada has spent $90,000,000 in improving and deepening the St. Lawrence, and this does not include the vast sums expended by the Montreal Harbor Board and the ports of Quebec and Levis on their respective harbors.

Roominess. The importance of this factor is not likely to be fully realized by a "landsman." A modern liner requires about half a square mile of free space in which to turn around, even when helped by tugs. Without the assistance of the tugs she would require far more. Take the case of the *Imperator.* The ship is nearly 1,000 feet long, nearly 100 feet wide, and over 60 feet from the keel to the upper deck. When she docked in New York for the first time it was not realized by the river pilots and captains of other ships how much room she required in which to turn. Consequently she bumped two or three other ships and ran into a wharf, doing damage to the extent of $45,000.

Dockage Space. This is very important. A ship must be able to dock quickly and discharge her cargo, receive another, and depart. Every day she is in dock she is costing the owners money and earning nothing. In the keen competition of modern commerce this is fatal.

Liverpool, Manchester, Glasgow, London, Southampton, are examples in Great Britain of ports providing excellent docking facilities. New York has, however, perhaps made better provision for this than any other port. It has a water frontage of 771 miles, of which 290 have been improved. The port of New York suffers, however, from congestion, as it is the only harbor in the United States having a channel deep enough to take vessels drawing 40 feet of water. Boston is an example of a great port held back by lack of dockage space, but it is rapidly being improved in this respect. It is handicapped in having a channel of only 35 feet.

Halifax is an example of a Canadian port having splendid terminal facilities.

Building Space. The importance of this is too obvious to call for comment.

Communication with the Interior. This factor, together with the character of the "hinterland," forms the most important requirement of a modern harbor.

A harbor may possess the requisite depth, roominess, and dockage facilities, and afford the necessary protection for shipping, but it will be at serious disadvantage unless it has good communication with a populous hinterland. There are many examples of how lack of adequate and easy communication with the interior results in there being no seaport on what would otherwise be splendid harbors. For example, Milford Haven, in South Wales, has a very fine harbor, but it has little commercial value because other harbors have very much easier communication with the same hinterland. Among Canadian ports which are heavily handicapped in this respect, we may cite Halifax, N.S., S. John, N.B., and Victoria, B.C. Montreal and Vancouver are Canadian ports having favorable communication with the interior.

New York is the classic example of this type, since it is situated at the seaward end of the easiest route through the Appalachian mountain chain to the interior plain. Liverpool in England lies at the mouth of a navigable river, and the South Lancashire and the Cheshire plains give easy land access to the manufacturing districts of Lancashire, the Midlands, and the great mart of London. The Aire Gap provides an easy grade across the Pennine Range, giving a natural route to the great Yorkshire manufacturing districts around Bradford and Sheffield.

Character of the Hinterland. This determines the trade of the harbor. No harbor is commercially valuable unless it can command plenty of business. This business depends not so much

upon the seaport as upon the other places which are tributary to it. The value of a hinterland depends largely upon four subfactors:

(1) The number of its inhabitants.
(2) Their power to produce and purchase goods.
(3) The activity of its inhabitants.
(4) Its size.

Of these factors, size is of the least importance. Once a seaport is established, if it has the necessary seven factors of a seaport in their due proportion, it commences to grow, and to accommodate a host of workers. Some sell food, clothing, and the necessities of life. Others serve as clerks, stenographers, teachers, bankers, mechanics, and all the various classes of people who are needed in every large community. In this way a city arises beside the harbor. Such a city, be it a port on an ocean, a river, or a lake, possesses many advantages over other types of cities. The manufacturer finds it easy to collect the raw materials for his factory at such points and to distribute them when manufactured. He can easily build up a foreign trade, since he is brought more directly in contact with representatives from other markets than if he were located inland.

In all parts of the world the demands of commerce cause the greatest cities to be located beside the sea; 23 out of the 40 largest cities in the world are seaports, and two of the remainder are great lake ports.

276. The Commercial Importance of the Sea. Year by year the ocean-borne commerce of the world increases. The lines of steamship traffic are the very veins and arteries of commerce. "The great problems of the nations of today are the problems of easier access to the sea; of more and better harbors; of larger docks and more commodious warehouses; of ampler and easier railroad feeders.

"To entice the big steamship lines away from one port to another, to secure lower rates between this port and inland ports or cities, or to obtain faster service which shall enable it to deliver letters or goods a few hours earlier than its rival—these are the great problems of peace.

"The problem of war is to keep open these ports, to protect the steamship lines and to prevent the strangulation of this life-giving commerce. So the sea becomes not only a great thing to be defended, but is in itself a great defender.

"Its ships in time of war become the carriers of soldiers, and munitions and food. They are also turned into the most terrible engines of destruction yet devised by man. To provide for their construction and housing, to protect them from enemies, and to satisfy their demands for munitions and supplies become the chief concerns of the modern state."—*The Things Men Fight For*—H. H. Powers.

The sea, sea trade, and sea power are the very life of our modern commercial system, and to understand world commerce we must first know the part played by the ocean.

The nation that does not touch the ocean is like a house that is not on the street. It is dependent upon the good-will of the neighbors for access. Once a nation has reached the sea it has possessed itself of part of the world highway that reaches everywhere, and that belongs to each and all who own a tiny strip of coast. This shift of the emphasis from land to sea was recognized by the great powers of the world at the Treaty of Versailles. Look at the devices employed to give the new nations access to this great highway of the sea:

Poland's corridor to the sea through Eastern Prussia, and the internationalization of the German port of Danzig.

The internationalization of the great German rivers, the Elbe and Oder, in order that Czecho-Slovakia might find easier access to the sea front and not be dependent on her late enemy, Germany.

The sacrifice of gallant little Montenegro in order that Yugo-Slavia might have a port on the Adriatic.

The extension of the Danube International Commission.

These all bear eloquent testimony to the modern view of the importance of access to the sea, and to the free and open highway it affords commerce.

Trade Routes of North America.

277. Domination of the Great Lakes in Determination of Routes.

An examination of a railroad map of North America will show that most of the trade routes of the continent converge on the Great Lakes. That is to say, the lakes are the dominating factor in fixing the trade routes of the continent. This domination is due to the following factors:

(1) Their location.
(2) Their great area and the direction of their longest dimensions.
(3) The position of their outlets.
(4) The hinterland.
(5) Cheapness of water transportation.

Location: They are located in that part of the continent which, climatically and every other way, is the most favorable to human activity.

Area, etc.: They form all together the greatest connected sheet of fresh water in the world. The east and west direction of their longest axis enables them to penetrate to the heart of the continent. Their depth makes them suitable for navigation by large steamers.

Position of their outlets: The two main outlets are the natural water outlet via the St. Lawrence River and the land outlet via the Mohawk and Albany River valley. The latter is the more important. This is due to three principal factors:

(1) The freezing-up of the St. Lawrence for about four months each year.
(2) The rapids on the Upper St. Lawrence.
(3) The easy grades for railroads and canal down the Mohawk and Albany River valleys.

The great dominating feature about the outlets is, however, that they both give direct access to the busiest ocean trade route in the world.

The hinterland: This, of course, is the greatest factor of all. Within easy reach, across a region very favorable to railroad construction, lie the greatest areas of wheat-producing land in the world, viz., the Canadian prairie provinces, and the Dakotas and Minnesota. Practically all the grain transported from these regions passes over or around the Great Lakes. Around Lake Michigan is the great corn belt of the United States with its production of hogs, corn and corn products waiting to be transported to the great centres of manufacturing. In addition, the western areas contain the richest and largest as well as most easily worked deposits of iron ore in the world. The same area is also one of the world's great copper regions. On the Canadian side, copper, nickel, salt, and oil are also produced. The forests of Ontario and Michigan and Wisconsin contribute vast amounts of lumber and pulp to the trade of the region. The eastern sections of the area in the United States are vast storehouses of coal, which is mined and shipped for smelting these iron ores, or to be used for heating purposes in the coalless regions of the middle west.

Cheapness of water transportation: The character of the Great Lakes allows the use of large vessels. This means less overhead for the amount of tonnage shipped. Therefore, this one fact alone would tend to make lake freights cheap. But the development of the specialized vessels as carriers for grain and iron ore and perfecting of mechanical methods of loading and discharging cargoes have reduced them still further. Therefore, the freight rates on these lakes are a mere fraction of the land rates. These advantages have made the lake ports the terminals of most of the railroads of the middle west.

The Great Lakes. This magnificent expanse of inland waters is of the utmost importance to North America and is, without doubt, the busiest sheet of water in the world, notwithstanding the fact that it is frozen over four to five months each year.

Centering round this great sheet of water are the greatest commercial highways of the continent.

We may distinguish the following trunk lines on the Great Lakes:

(1) The chief trunk line from Duluth to Buffalo on Lake Erie.
(2) The Lake Michigan trunk line from Chicago and Milwaukee on Lake Michigan to Buffalo on Lake Erie.

The Canadian trunk line:

(3) From Lake Superior and Lake Michigan ports to the Canadian ports on Georgian Bay, especially used in the movement of Canadian grain from Port Arthur and Fort William.
(4) Diversions from the chief trunk lines through the Welland Canal, Lake Ontario, and the St. Lawrence River and canals to Montreal.
(5) Cross lines between Lake Michigan and Lake Superior ports.

Iron ore, lumber, grain, and coal form the major part of the freight carried on these routes.

The greatest obstructions to the navigation of the lakes are the differences of level between them, and the limestone reefs of the Detroit River.

To overcome the first, canals have been constructed around St. Mary's Falls between Lakes Huron and Superior. These form the well known "Soo Canals," two on the United States side and one on the Canadian side. The Canadian "Soo" Canal carries about a quarter of the tonnage passing from one lake to the other.

The other difference in level is the drop between Lakes Erie and Ontario which produces the Niagara Falls. This is the most difficult obstruction of all. To overcome it the Canadian Government constructed the Welland Canal from Port Dalhousie to Port Colborne. Unfortunately the locks on this canal are too small to take the bigger lake steamers. At the present time Canada has under construction a ship canal around Niagara Falls, viz., the Welland Ship Canal, which will be 25 miles long and will have a depth of 25 to 30 feet of water. This will enable much larger vessels to pass through than at present, and this should have a stimulating effect on Canadian-borne freight.

The other obstacles to navigation, namely, the reefs in the Detroit River, have been removed by blasting, and a 21-foot channel is maintained. The United States outlet for the Great Lakes' traffic to the seaboard is principally through Buffalo, and is accomplished by means of railroads and the Erie Barge Canal. These roads and canal follow the Mohawk-Hudson valley to New York City. This valley is one of the most important thoroughfares of trade in the world.

Movement of Freight on the Great Lakes. The greatest movement is from west to east, since this is composed almost entirely of the raw materials of manufacture, and of food-stuffs. Ninety per cent. of the lake traffic is confined to four commodities: iron ore, grain, flour, and lumber.

Iron ore accounts for almost half the annual tonnage moved and six ports handle practically all of it. These are: Duluth, Two Harbours, Superior, Ashland, Escanaba, and Marquette. At least half of this is handled by the ports of Duluth and Two Harbours. About ninety per cent. of the iron ore is received by the Lake Erie ports, of which Ashtabula, Cleveland, Conneault, Erie and Buffalo are the chief. The only important iron-receiving ports not on Lake Erie are Chicago and Gary.

Wheat is shipped mainly from Port Arthur, Fort William, Duluth, Superior, Chicago, Milwaukee and Toledo. The principal grain-receiving ports on the lakes are Buffalo, Erie and Ogdensburg in the United States.

The great receiving port in Canada is Port Colborne. All the wheat destined for the sea via the St. Lawrence waterway must pass through this port. At the present time the 14-foot depth limit of the Welland Canal renders trans-shipment necessary. The added expense has led to the establishment of great flour mills at Port Colborne where much of this wheat is milled before being shipped farther. In 1924 this port handled 23-000,000 bushels of transfer grain in private elevators and nearly 60,000,000 bushels in the Government elevators, or 83,000,000 bushels in all. Here is situated the largest flour mill in the British Empire. It has a capacity of 14,000 barrels of flour per day of 24 hours.

Lumber is sent from many ports both in Canada and the United States, Duluth having the greatest importance. Chicago is the principal destination of the lumber.

The westbound traffic is largely coal and manufactured goods. Buffalo and Erie receive anthracite from Pennsylvania, and ship it to Canadian and United States ports, especially along the shores of Lakes Ontario, Michigan, and Superior. Bituminous coal is shipped from many Lake Erie ports of the United States to great storage yards at receiving points along Lakes Michigan and Superior—Milwaukee, Superior, Duluth, Port Arthur and Fort William being the chief.

St. Lawrence Waterway. The value of this waterway to both Canada and the United States is enormous. It affords a deep-water route from the heart of the continent to the Atlantic seaboard. The disadvantages of depth and current have been at least partially overcome by the construction of canals around the most unfavorable places. These canals can be considered in two groups, viz.: Those which form part of the St. Lawrence River proper and those which belong to the Great Lakes. Since the St. Lawrence River is for the most part a Canadian stream and its sea outlet entirely in Canadian territory, the principal attempts to make it navigable are Canadian. These Canadian endeavors have resulted in six separate canals between Montreal and Prescott.

Name, Location, and Length of Canals	No. of Locks	Length of Lock	Width of Lock	Depth of Lock
Lachine (Montreal to Lachine, 8.5 miles)	5	270	45	14
Soulanges (Cascade Pt. to Coteau Ldg., 14 miles)	5	280	45	15
Cornwall (Cornwall to Dickinson's Ldg., 11 miles)	6	270	45	14
Farran's Pt. (Farran's Point Rapid, 1.25 mile)	1	800	50	14
Rapide Plat (Rapide Plat to Morrisburg, 3.67 miles)	2	270	45	14
Galops (Iroquois to Cardinal, 7.33 miles)	3	270	45	14

These canals are all too shallow for the use of large freighters, and so the traffic is carried on by means of smaller lake boats as far as Montreal, where trans-shipment to ocean carriers takes place. The great disadvantage of the St. Lawrence is that it is frozen over for four months each year.

Canada has under consideration a scheme for the fuller utilization of the St. Lawrence by the construction of the Georgian Bay Ship Canal. The advantage to be gained by such a scheme is that it would greatly decrease the distance between Lake Huron and the Atlantic Coast. It would also provide, along with the Canadian "Soo" Canal and the Welland Ship Canal, an all-Canadian route for the ever-increasing supplies of grain from Western Canada to the Atlantic seaboard.

Far too much Canadian grain is, under present conditions, transported to the seaports by United States railroads.

278. Canal Systems of America. Prior to the era of railway construction in North America there were built a number of canals. The people depended for transport, mainly, on the fine rivers of the continent and on canals. The necessity for rapidity of transport in order to settle the rich plains of the interior, however, led to the virtual abandonment of inland waterways in favor of the railroad. In the period of inland waterway development the efforts were mainly concentrated on three types of undertakings:

(1) Efforts to connect the Great Lakes with the Atlantic Ocean.

(2) Efforts to connect the Great Lakes with the Ohio and Mississippi.

(3) Efforts to connect the Ohio River with the Atlantic.

In Canada the military necessity for a route between the lakes and Montreal which should be wholly Canadian led to the building of the Rideau Canal by the Royal Engineers for the British Government.

Of the United States' efforts to connect the Great Lakes with the Atlantic by canal, only one was successful, viz., the Erie Canal.

Canals were also built in Pennsylvania, Maryland and Virginia, but the topography of the region proved unfavorable, and none of them succeeded in accomplishing the purpose intended. With reference to the efforts to connect the Great Lakes with the Ohio and Mississippi Rivers, two main canals across Ohio and one across Indiana connect Lake Erie with the Ohio. Another in Illinois connects Lake Michigan with the Illinois River, and so gives access to the Mississippi. A very short one in Wisconsin also provides a water connection between Lake Michigan and the Mississippi. These were nearly all successful commercially until the railroads were built. They then declined in importance and are now either abandoned or very little used. Of the post-railroad efforts to utilize the magnificent waterways of the continent we have the Chicago Sanitary and Ship Canal which has a bottom width of 202 feet and a depth of 24 feet and is 38 miles long. Its use, however, is restricted at present because the Illinois and Mississippi Rivers which it links with Chicago are not deep enough to allow ships of this draft to pass. It is a canal which is being watched with great interest by thinking Canadians, since, in order to make it, the Chicagoans have diverted more than their legal share of water from the Great Lakes. It is just now the centre around which a great legal fight is being waged. The result of this battle is fraught with the deepest interest to Canadians. If the people of Chicago are successful in this attempt to divert the water in spite of the international agreement, there is little doubt that a great deal of the traffic would be diverted down the Illinois and Mississippi Rivers to the Gulf of Mexico. Also, the old Erie Canal has been deepened to 12 feet and partly relocated. It has not, however, been a success in its new form, for up to 1923 it had carried less than 10% of its traffic capacity and even less than the old canal carried. Another canal which has been deepened is that connecting Lake Champlain with the Hudson River.

In 1914 the Cape Cod Ship Canal was opened. This canal has a depth of 25 feet and allows vessels drawing less than that amount of water to avoid the stormy passage around Cape Cod. It is 13 miles long.

Numerous canals have been constructed in the United States in connection with the Great Lakes, which provide short cuts around certain points.

In Texas there are two ship canals taking vessels up to 24 feet draft. They connect Port Arthur with the Sabine River.

In Washington a ship canal from Puget Sound allows vessels up to 30 feet draft to enter Lake Washington, behind Seattle. There are, besides, numerous canals of small depths in many other parts. In Canada, in addition to the canals of the St. Lawrence and Great Lakes already mentioned, there are:

The Chambly Canal, which gives an inland water route between Montreal and New York. It follows the Richelieu River Valley into Lake Champlain, where it connects with the Champlain and Hudson Canal of the United States.

The Ottawa River Canals. These were constructed to enable river craft to navigate from Montreal to Ottawa. They comprise the Lachine Canal; the Ste. Anne Lock, which overcomes the Ste. Anne Rapid; the Carillon Canal, which was constructed to avoid the Carillon Falls; and the Grenville Canal, which was also built to avoid a rapid.

The Trent Canal. This forms part of a system of navigation extending from Trenton on the Bay of Quinte to the Georgian Bay. The navigation is of little commercial value. It owes its economic importance to the water-power facilities along its route. It is also noted for its hydraulic lift lock at Peterborough, capable of lifting an 800-ton vessel a vertical distance of 65 feet.

The Murray Canal is an open waterway across the isthmus of Prince Edward County. It allows vessels to pass directly from the Bay of Quinte into Lake Ontario.

St. Peter's Canal. The most easterly of all Canadian canals. It connects St. Peter's Bay with the Bras d'Or Lakes. It will accommodate vessels drawing less than 18 feet of water.

St. Andrew's Lock is the only canal effort in Western Canada. It was built to overcome the rapids of the Red River, fifteen miles north of Winnipeg. It was opened to traffic in 1910. Vessels of 16 feet draft can pass through this lock. It gives Winnipeg connection with Lake Winnipeg.

Projected Canals in Canada. The Georgian Bay Ship Canal and the deepening of the St. Lawrence waterways are the most important projected canal schemes.

The Georgian Bay Ship Canal would follow the Ottawa and French Rivers from Montreal into Georgian Bay. The great initial cost and the loss of time for locking operations are the most serious obstacles to its being undertaken.

The St. Lawrence Deep Waterway Scheme for navigation purposes and hydro-electric power development has been for some years the subject of negotiations and investigations by the joint governments of Canada and the United States. It has been agreed to defer the undertaking. If the plan is ever carried out it will involve much canal construction.

279. Mississippi River Traffic. During the period of the early development and settlement of the central United States the magnificent waterway of the Mississippi played a great part. Today it has no such commercial significance.

On looking at a map it would appear that this waterway should be a great commercial artery; but it has one almost overwhelming drawback. It enters the sea at the wrong place. True, the Panama Canal has partially overcome this handicap. The relief is, however, not sufficient. The great populations which need the products of the hinterland lie at right angles to the river's course and thousands of miles away from its mouth. It

may be that through the development of United States trade with South America and the Orient via the Panama Canal this waterway may increase in importance. This is, however, very doubtful; since the ocean connection between New York and these points is quicker and superior in almost every respect than the Mississippi can provide. There are other minor difficulties in the way, e.g., the winding nature of its course and the heavy seasonal floods.

280. Transcontinental Railroads of Canada and the United States. Nine main lines cross the widest part of the continent, two in Canada and seven in the United States.

Descriptions of their routes are to be obtained in any elementary geography. It is only necessary to note here that they pour the bulk of their traffic into nine great ports, viz., Montreal, Boston, New York, Philadelphia, Baltimore, on the east coast of the continent; New Orleans on the Gulf of Mexico, and Vancouver, Seattle and San Francisco on the Pacific Coast. These are, so to speak, the main water gates of the continent.

Another feature of railroading on the American continent is that the strictly transcontinental traffic, outside passengers and mail, is not large. The chief purpose of the railroads is to deliver freight to the east and west collecting ports on the Great Lakes, and to carry from them the manufactured goods and fuel to the areas producing raw material. These are the great factors which make Chicago and Winnipeg such important railroad centres.

281. Hudson Bay Route. Owing to the shape of the earth the western coast of Hudson Bay is from 100 to 200 miles nearer Liverpool than the port of New York.

The great wheat fields of Canada are also much nearer this coast than they are to Lake Superior. If Canadian wheat could be shipped to Europe via this route there would be a great saving in railroad freight rates. This has set Canadians considering the opening up of a new grain route to Europe via Port Nelson or Fort Churchill on Hudson Bay. A railroad was constructed to within a short distance of Port Nelson; but in 1927 it was decided to make Churchill the terminus of the road. The Hudson Bay has only a few months' open navigation season, and its entrance is greatly menaced by icebergs. It is feared that these drawbacks may seriously impair the usefulness of this route as a grain outlet. The high insurance rates consequent on the ice menace, together with the huge expenditures necessary to provide grain storage capacity and other terminal facilities, are also powerfully deterring factors. There is little doubt, however, that the railroad, when completed, will prove a great benefit in opening up the mineral and pulp wealth of the region through which it passes.

282. Routes of Mexico. Mexico is a very rich country, both as regards mineral and agricultural wealth. It is, however, a very badly governed land. This factor is preventing its full development. The topographical features of the region are such that the difficulties of connecting the west coast with the eastern ports are very great. Consequently the trade routes of Mexico are largely continuations of the United States railroads.

It has one transcontinental railroad across the Tehuantepec isthmus. This was originally built by the Mexican Government. It was sadly mismanaged, and allowed to fall into bad repair. It is now leased to an English company, which put it into good repair and improved its terminals. The road suffers badly, however, from the competition of the Panama Canal. The city of Mexico is connected by rail to the coast. In Yucatan there are three small isolated railroads which obtain freight from the sisal hemp plantations there. They all terminate at the port of Progreso.

The mountains of Western Mexico are rich in minerals, but there is no railroad connection with them, mule pack trains forming the usual means of transportation. The opening of the Panama Canal should greatly stimulate the building of railroads in Mexico if the government can be stabilized.

283. Relation of the Panama Canal to Trade Routes of North America. The coastwise shipping of the United States has greatly increased as a result of the opening up of the new route via the Panama Canal. The railroads, on the other hand, have been heavy losers through the diversion of freight to the water route. Trade with the Gulf ports and the Mississippi waterways has been greatly stimulated. Canadian wheat is being shipped in increasing quantity from the Alberta wheat fields via Vancouver to Liverpool. Canadian lumber and canned salmon are now largely shipped via the Panama Canal.

Trade Routes to Europe.

284. Natural Advantages of Europe for Commerce. No other continent has so many natural advantages as has Europe. They may be summed up as follows:

(1) The irregular nature and great length of her coastline. These features result in bringing nearly every part of Europe within easy reach of the sea.

(2) The large indentations of the coastline, which carry the sea to the heart of the continent.

(3) The east and west direction of the main mountain masses. They, therefore, present little resistance to the development of railroad traffic routes.

(4) The favorable distribution and direction of the navigable rivers.

(5) The position of the island fringe on the busiest ocean of the world.

(6) The concentration of the great manufacturing areas in a climatic region favorable to human health and energy.

(7) The ice-free condition of all her great ports.

(8) Europe possesses no large isolated plateaus and its only region of interior drainage is a small area in the far south-west corner.

(9) The great variety of climates and soil unite in producing regions which differ widely in products and economic conditions. This factor greatly stimulates intercontinental trade, since trade arises out of diversity of products and differences in degrees of industrial development.

285. The Two Heavy Traffic Routes. Transportation in Europe is of a highly complex nature. Natural waterways, canals, railroads, and fine roads all are made to contribute their share in solving the transportation problem, which is the greatest of all commercial problems. European transportation is broadly divided between two types of traffic routes, viz.:

(1) Heavy traffic routes, which are principally water routes.

(2) Fast traffic routes, which are mainly overland railroad systems.

Each of these develops main trunk routes with hosts of subsidiary feeders. The heavy traffic routes form two main trunks following the two great systems of seas, viz., the Mediterranean, with its subsidiary branches, and the North Sea, with its great extension, the Baltic.

286. The Great Southern Route extending from Gibraltar to Novorossiysk and Batoum forms one of the great traffic routes of the world. It has the disadvantage of a great mountain wall cutting off a great hinterland along the major part of its northern shores. It is also deficient in secondary feeders of first class importance until the Black Sea is reached. For the whole of that distance, more than three-quarters of its total length, the Mediterranean does not receive any European river of first class importance, the Rhone, the Ebro, and the Po being the largest rivers it receives in this long distance.

But on reaching the Black Sea all this is changed. For this sea receives the mighty Danube, which forms a navigable road right into the very centre of the continent, through one of the most fertile and productive regions of Europe. So important is this river to the countries through which it passes that it was made an international highway prior to the Great War. It is administered by the International Danube Commission. A canal has been cut through its great swampy delta in order to avoid the dangerous navigation through its distributaries. Here are located the Rumanian ports of Galatz and Braila. At these ports ocean-going steamers receive the grain of Hungary. China and

other manufactured goods from Czecho-Slovakia are also sent down this great river, as well as lumber from the slopes of the mountains of Central Europe. Still farther east, the great southern route receives those fine Russian rivers, the Bug, Dneister and Dneiper. These rivers, together with some South Russian railroads, feed the great grain ports of Odessa, halfway between the Dneister and the Bug; Nicolaief, on the Bug; and Kherson, on the Dneiper. Still farther east, the Sea of Azov receives the waters of the Don, which collects the harvest from this basin. Here are the grain ports of Taganrog and Rostov. Besides these great feeders, which collect the products of an area equal to about half of the continent, there are railroads and pipe lines which connect Novorossiysk, Poti and Batoum with the Caspian Sea and the magnificent Volga River, whose valley is perhaps the most fertile land of Russia. At present, owing to the disturbed condition of Russia, none of these feeders excepting the Danube are contributing anything like their usual quota of trade to this route. In normal times, however, tramp steamers congregate at these ports by the hundreds to receive the products of what is, without doubt, one of the greatest hinterlands of the world. The three great peninsulas—the Balkan, Italy, and Spain—with the islands along the route, contribute immense quantities of olives, currants, figs, silk, wool, etc., to the great stream of traffic on this important trunk route.

287. The Great Northern Route. This is more favored than its southern partner because:

(1) It has more and better distributed subsidiary feeders.

(2) The greater distance of the mountain rampart of the Alps from the northern coast line of Europe produces a less rugged relief and provides long drainage slopes which are traversed by navigable rivers.

(3) The construction of canals and railroads is facilitated by the topography of the land.

(4) This water route serves the region of greatest industrial and commercial activity of the world.

(5) It is in direct connection with the world's busiest ocean highway.

The nations living around this great highway of trade have not been slow to develop and make use of its natural advantages. Here also the four great means of inland transport have been co-developed to an extent seen in no other region.

River, canal, road and railroad are all forced into service with the result that this route is served in a highly efficient manner by its subsidiary feeders.

The greatest of these subsidiary feeders are the very important valleys of the Elbe, the Weser, the Rhine, the Meuse and Scheldt, and the Seine. In a lesser degree, but still of great

importance are the Tagus in Spain and Portugal, and the Garonne and Loire in Western France; while the Oder, Vistula, Niemen and Dwina empty into the Baltic across the great plain of Europe. These rivers are supplemented by a veritable network of canals which connect them with each other and with various industrial centres. Notice the great ports at their mouths:

Lisbon on the Tagus.

Bordeaux on the Garonne.

St. Nazaire on the Loire.

Havre on the Seine.

Antwerp on the Scheldt.

Rotterdam on the Maas with the Rhine and the ports of Antwerp and Amsterdam within easy reach by water.

Hamburg on the Elbe.

Bremen on the Weser.

Stettin on the Oder.

Danzig on the Vistula.

Riga on the Dwina.

Of the above Hamburg, Antwerp, Bremen, and Havre are listed among the fifteen largest ports of the world. If the British port of London be added, which is quite proper, the route contains exactly one-third of the fifteen greatest ports in the world. An examination of the remaining members of the list will show that five more, Bordeaux, Amsterdam, Stettin, Danzig and Riga are ports of first class importance. No other region can show such an array, and it must be remembered that the list does not include such British ports as Southampton, Newcastle, Hull, Grimsby, Leith, etc., nor the Danish port of Copenhagen, nor Oslo (formerly Christiania), nor Stockholm, all of which contribute largely to the traffic movement along the route. The great variety of shipping found along this route, from small coastal sailing vessels to large and powerful freight steamers, carry the heavy freight of Europe by ship or barge directly to every country in Europe excepting Switzerland and a part of Yugo-Slavia. The main commodities carried are wine, olives, olive oil, currants, figs, etc., from the great peninsulas of the Mediterranean; grain from Hungary and Russia; petroleum from Rumania and the Caspian Sea oilfields; sugar from Germany; lumber from Scandinavia, Finland, Latvia, Esthonia, and Lithuania; grain from the three last mentioned lands, and in normal times from South Central Russia; sulphur from Sicily; iron ore from Northern Spain and Sweden. Coal is carried from Britain to nearly every European country. Cement, glass, and iron from Belgium, and the heavy machinery and other manufactures of Great Britain, France, Germany, and Czecho-Slovakia are also carried over this route.

288. Importance of the Canal and River Transportation of Europe. The principal canals and canalized rivers in Great Britain are: The Manchester Ship Canal. This is one of the most important canals in the world. It is only 35½ miles long. It follows the Mersey River to its junction with the Irwell and thence up the Irwell Valley to Manchester. It makes it possible to convey raw cotton direct to the great cotton centres around Manchester without breaking bulk at Liverpool as was formerly the case. Another canal of great importance in England is the Leeds and Liverpool Canal which connects the great woolen manufacturing districts of England with the port of Liverpool. It also puts Liverpool into water communication with Hull and the ports of the Humber. Other important canals in England are the Grand Junction Canal, which connects the Thames and the Trent Rivers; the Trent and Mersey Canal, which connects the Mersey with the Trent, and gives water communication through the Grand Junction Canal with London.

These canals (except, of course, the Manchester Ship Canal) are only barge canals and, although they handle large amounts of traffic (especially the Leeds and Liverpool Canal), their usefulness is impaired by the shallow draft. Schemes for removing this defect are at present under consideration.

France is well supplied with navigable rivers and the topography of the country is admirably suited to the linking of them by means of canals. About one-half of the internal trade of France is carried on by means of inland waterways. The canals are nearly all controlled by the government and the rates are low. The Canal du Midi is 150 miles long and connects the Garonne and the Rhone Rivers. Several of the French rivers are connected by canals to the Rhine. Belgium and Holland are also well supplied with canals, which, together with the Meuse, Scheldt and Rhine Rivers, carry a very large tonnage.

The Rhine is the most important waterway in Europe. Large sums have been expended in improving it, especially in deepening it and smoothing out its curves. It also traverses a region of great industrial importance and has canal connections with many other rivers.

In Western Germany we find a plain drained by navigable rivers which are connected by a network of canals. The canals, as well as the railroads, are controlled by the government, and are splendidly articulated with the other traffic routes.

The Kiel or Kaiser Wilhelm Canal is a ship canal crossing the base of the Jutland Peninsula. It saves two days between the German Baltic and North Sea points. It is also a canal of great military significance.

Russia. This country is largely a great plain with fine, large rivers having sluggish currents. These rivers are navigable for long distances. Two of them, the Ural and the Volga, unfortunately drain into the Caspian Sea. Others, like the Petchora and

the Northern Dwina, empty into the Arctic Ocean. But, nevertheless, much use is made of these great internal arteries and an immense movement of tonnage takes place annually upon them. Many canals have been constructed to divert traffic from them into the Black and Baltic Seas.

The chief importance of these inland waterways is that they give almost every manufacturing city of industrial Europe water transport to and from the great seaports. These cities, therefore, have the advantage of very cheap rates on the primary raw materials of industry, like coal, lumber, iron, stone, cotton, grain, etc., and they have a similar advantage in cheap rates when sending their finished products to the seaboard.

289. Fast Railway Traffic on the Overland Routes. The enormous volume of business transacted in Europe necessitates regular, rapid, and frequent communication for mail and passengers between the great centres of population. This type of communication is not furnished by the heavy traffic routes just described. It is the main purpose of the railroads of Europe. The railroads are, therefore, mainly concerned with carrying mail and passengers. They also carry such freight as is perishable, valuable, or urgently required. Therefore, we find all the great cities of Europe splendidly served by fast rail connection. The "through express" is a feature of the type of service thus given. The many nationalities of the continent, and the small size of some of the countries, are great factors operating against the construction of vast transcontinental systems operating under one management like our Canadian National and Canadian Pacific Railways. Nevertheless, the urgent necessity of rapid and frequent communication has led to such close co-operation among the European systems that they give a type of through transcontinental service which is not surpassed anywhere. In addition, since the war aerial transportation has been inaugurated. This will be considered later.

Although Paris is the great railway centre of Europe, London is the starting point for this fast passenger and mail service to the rest of the continent. This is principally due to the maritime supremacy of Great Britain and also to the fact that more British ports are nearer to open ocean than are those of any other country in Europe. This means that as soon as a mail or passenger vessel reaches a British port, the mail and passengers are transferred to the fast railroad routes, instead of proceeding by the slower water route to the continental ports. For example, American mail entering Europe is discharged at Queenstown in Ireland, Falmouth, or Southampton, and sent by special non-stop trains or combinations of trains and ferries to London. From here it is distributed by a wonderful system of train and ferry to every capital of Europe. The out-going European mail is also rushed to the out-ports of Britain by the train and ferry services which overtake the boat at Queenstown, etc. The case of the Indian and Australian mails is especially interesting. These

mails are rushed, along with special passengers, by through expresses and fast packet-boat, from London, across the Channel to Calais, and into Paris. Here they catch a special train which with very few stops carries them to Brindisi in South Italy, where the boat puts in to receive them. The return boat from India and Australia puts in at the same port and sends mail and passengers overland to London in a similar manner. This results in a saving of several days in the voyages to and from these countries. Paris, since it is closer to London and the Atlantic Ocean than any other of the great continental cities, has become the gateway of Continental Europe.

Take any large transportation map of Europe and study it a moment. It will be seen that Paris, of all the large cities of Continental Europe, is nearest to the English Channel and the Atlantic Ocean. One will discover that from Paris radiates in all directions a veritable network of railways, and that most of these extend beyond the limits of France to all parts of the Iberian peninsula, along the shore of the Mediterranean and the west coast of Italy to Rome and Naples, through Switzerland and down the Italian east coast to Brindisi, via Switzerland or Germany to Venice, Vienna, Constantinople in the Far East of Europe, to the Netherlands, to Berlin and the principal cities of Germany, to Warsaw in Poland and to Leningrad and Moscow in Russia, where connections are made with the Trans-Siberian Railway, thus giving all-rail connection with the Pacific Coast of Asia.

Some of the trains operating on these lines are famous the world over. Among them are such well-known through express trains as the Riviera Express, Interlaken Express, Geneva Express, Bordeaux and Biarritz Express, Bordeaux and Pau Express, Basle and Zurich Express, Simplon Express to Lausanne, Vienna and Trieste; Sud Express, and the Pyrenees-Cote d'Argent Express from Paris to Madrid, Barcelona Express, Carlsbad Express, Rome-Palermo-Taormina Express, Orient Express to Constantinople, and many other through trains of nearly equal importance.

Other important railway centres of continental significance in Europe are: Dijon and Lyons in France, Antwerp and Flushing in Belgium, Turin and Milan in Italy, Vienna in Austria, Warsaw in Poland, Moscow in Russia.

At all these centres there are similar radiating lines to those around Paris. Mention should be made here of the Alpine tunnels which enable these railroads to overcome this great barrier of mountains. There are five of these tunnels, viz.:

The Mont Cenis Tunnel, between France and Italy, 8 miles long, opened in 1871.

St. Gothard Tunnel, in Switzerland, connects the German centres with Italy. It is 9 1/3 miles long and was opened in 1881.

The Simplon Tunnel, In Switzerland. This is the largest railroad tunnel in the world. It is 12½ miles long and was opened in 1905. It gives connection between the Rhine valley and Italy.

The Loetschberg, in Switzerland, is 9¼ miles long. It was opened in 1913.

The Mont d'Or, in France and Switzerland, was opened in 1913, and is 3¾ miles long.

Trade Routes of Asia.

290. Geographic Handicaps to Transportation. Transportation in Asia suffers greatly from certain purely geographic hindrances. These may be summed up as follows:

(1) The great size of the continent.

(2) The lack of great indentations in the coastline.

(3) The height and extent of the mountains and plateaus with their location in the centre of the land mass.

(4) The presence of the great central belt of deserts.

(5) The large area of the inland drainage basins.

(6) The northern drainage into an ocean which is frozen for nine months of the year.

(7) The concentration of its densest populations in a few areas which are shut off from easy landward communication by the aforesaid high mountain masses, plateaus, and deserts.

Importance of the Rivers of Asia to Commerce—

The great influence of a navigable river emptying into an open sea is nowhere better shown than in Asia.

By far the greater portion of the heavy freight movement of Asia is accomplished on those great rivers which flow south and east over the plains from the Alps-Himalayan Ranges.

Consider them: The Euphrates-Tigris system, which gives a trade highway into the interior of South-West Asia. The Indus, which, with its tributaries the Sutlej, Jehlum, Chenab, Ravi and Beas, forms another great artery of trade into the North-Western part of India. The Ganges with its tributaries, the Jumna, Chambal, Gandak, Ghagra, and Goomti, provides another great water highway for the eastern side of Northern India.

The Brahmaputra is navigable for over 800 miles from its mouth, and, with its navigable tributary, the Megna, is extremely useful in the moving of tea and rubber from Eastern Bengal and Assam. The Irrawaddy is the greatest highway through Burma and is of untold value in bringing teak and rice to the great port of Rangoon at its mouth.

The Salween is another great river highway in Eastern Burma, with the port of Martaban at its mouth. The Menam, Mekong and Song Koi furnish the main transportation facilities for the movement of freight in Siam and French Indo-China. They deliver a great stream of freight into the ports of Bangkok, Saigon and Hanoi. In China the part played by those magnificent rivers, the Si Kiang or Canton River, the Yangtse Kiang, and the Hwang Ho, with their wonderful network of canals, gives China the leading place among nations of the world in inland water transport. The amount of traffic on these three rivers is stupendous, and over the area drained by them is concentrated the greatest single unit of population on the face of the earth. Practically 200 million people are estimated to be living in the basin of the Yangtse Kiang alone. The river is one of the greatest in the world. It is navigable for ocean-going steamships for between five and six hundred miles. It feeds the great port of Shanghai. In addition practically all the domestic commerce of Central China is carried on its waters or along its canals. Since there is little railroad development in China and the roads are of the vilest, it will be seen that these rivers and canals are of the utmost importance to the country.

291. Caravan Routes. Once away from these rivers the problem of transportation becomes very acute. Until the Russians built the Trans-Siberian and the Trans-Caspian railroads the commerce of the rest of Asia was carried on solely by the caravan. That is ,if we except the small railroad development in Asia Minor. Recall the topographical features of this vast area. The whole north of the continent is shut off by the tundra and ice conditions of the Arctic coastal lands. In the south is the stupendous wall of mountains reaching almost without a break in a vast curve from Asia Minor to the Malay Peninsula. From the centre of the continent a combination of great deserts and mountain ranges extends from Turkestan to the Arctic coast by Eastern Siberia. At the south-west corner is an area of desert tableland stretching from the Red Sea to the Euphrates-Tigris Valley. These are the handicaps with which the populations of Asia have to cope in carrying on overland trade outside the river areas just discussed.

For centuries the caravan has struggled against these stupendous difficulties. Horses, mules, donkeys, camels, and men have all been pressed into service. The distance covered by these caravans is enormous. Their objective is the rich market of Europe. The principal commodities carried are brick-tea, silks, furs, cottons and spices. The great centres of exchange between them and the European merchants are the Russian city of Nizhni-Novgorod on the Volga River, and Constantinople. At the great fair of Nizhni-Novgorod the Chinese trader from Pekin, the Tatar from Samarkand in Turkestan and the Nomads from the Khirgiz Steppes have for centuries rubbed shoulders with the merchants of Muscovy.

Another important caravan route is that connecting the Chinese province of Szchuen with Lhassa and Thibet. Yet another runs from Yunnan in South-West China into Upper Burma. In South-West Asia there was an old caravan route of the greatest importance. It ran from North-West India through Bagdad to Aleppo. From thence it ran to the sea at Alexandretta. At this point it swung north-west to the Cilician Gates. After passing the mountains here it bifurcated, one branch reaching Smyrna and the other Constantinople.

The penetration of the railroad into Asia has, however, caused the caravan trade to wane. All of these places have greatly shrunk in commercial importance, although some trading by caravan is still carried on from most of them.

292. The Trans-Siberian Railway. This railway is doing for Siberia what the early railroads of North America did for this continent. It is opening up vast tracts of fertile land for settlement. The great difference between the two continents, however, is that the settlement is proceeding from both ends in Siberia instead of one end only, as in North America. There is a Russian penetration of colonists from Europe and a Mongolian penetration from Manchuria and Korea. At the present time it is a line without branch railway feeders, the function of feeding the railroad being still left to the river boats and caravans. The country through which the line first passes after leaving Leningrad is of the steppe type, viz., rich grassy plains with "black earth" soil. In fact, the country is very similar to the prairie provinces of Canada. The great length of this railway is one of its disadvantages, it being more than twice the length of the main lines of either of our Canadian transcontinental systems. The railway commences at Leningrad, passes through Moscow to Samara on the Volga, where it forks. One line crosses the low range of the Ural Mountains and becomes the Trans-Siberian Railway. The other turns to the south and goes to Russian Turkestan. The Trans-Siberian line, after crossing the Urals, passes through a great mining region which yields platinum, gold, etc. It then passes the continental boundary into Asia. Omsk is the first important town reached. It is situated on the Irtish River and is a port for river traffic with the north. Tomsk, on the River Tom, is reached by a small branch line after crossing the River Ob. The next important stream is the Yenesei River. The railroad is linked to the town Yeneseisk by steamboat. Omsk, Tomsk and Yeneseisk are the centres of rich farming districts. They are also collecting points for forest products, and distributing centres for imported goods.

After leaving the Yenesei River, the country becomes hillier and covered by coniferous forests. Lake Baikal is next reached. In the summer this lake is crossed by a train ferry. In the depth of winter a temporary track is laid on the ice, whilst in the spring and fall the railroad skirts the southern shore. After leaving the lake an upland region is reached. This region is

very rich in gold reefs and is mined by convict labor. At Chita the railroad forks, the north branch reaching Vladivostock by a curving route through Russian territory. The south branch goes through Manchuria to Harbin where it branches again, the north fork going to Vladivostock. The south branch goes to Mukden, where it again branches, one line running into Port Arthur and the other continuing south to Newchang and Pekin. This very long railway was constructed in a cheap manner, of light material, by the Russians for military purposes. Before it can be of much use as a great highway of commerce much rebuilding will be necessary. It does not appear that it will ever carry much transcontinental freight. Its function, as a commercial route, will be to carry Western Siberian freight to the European centres and Easter Siberian products to the Pacific ports. The actual result at present is that North American and Japanese manufactured goods are being sent far into Eastern Siberia, whilst Western Siberian towns and settlements receive the machinery and other manufactures of Europe.

293. The Trans-Caspian Railways. Between the east shores of the Caspian Sea and the great mountain rampart which separates Russian and Chinese Turkestan, there lies a great arid region. Its topographical features prevent easy communication with the rest of the world. It formerly comprised the Russian territories of Trans-Caspia and Turkestan together with the Khanates of Bokhara and Khiva. These Khanates were vassals of Imperial Russia, but today their status is rather difficult to determine. Trans-Caspia and Turkestan are now known as the Socialist Soviet Republic of Turkestan. This Soviet republic is loosely federated with the other Soviet republics which comprise present-day Russia. For purely military purposes the Russians built two lines of railroad into this region. Although they were primarily military roads they had a stimulating effect upon the commercial development of the region. The Trans-Caspian railway starts at the port of Krasnovodsk on the Caspian Sea and passes along the base of the Elburz mountains in North-East Persia, then north-eastwards through the oases of Tejen, Merv, Charjui and Bokhara to Samarakand. From Samarkand it runs still east to Kokand and Andizhan. This is a total distance of 1,268 miles from Krasnovodsk. From Merv a branch runs south to Kushk on the Afghan boundary. This branch is of great potential importance since it practically links Russia with India. The other railroad line is a branch of the Trans-Siberian Railway. The branch commences at Samara and passes through Orenburg, at which place it crosses the Ural River. From here it runs round the north side of the Sea of Aral to Tashkent; passing through this city it strikes the Trans-Caspian line between Samarkand and Kokand.

The building of these lines provided this enclosed area with a means of access to the European markets. Cotton, astrakhan

fur, leather, apricots, and silk cocoons furnish the major portion of the outgoing freight. Before the war Russian Turkestan supplied about a fifth of the cotton used in the Russian mills.

294. The Bagdad Railway. This railway owes its existence to the German dream of a great empire extending from the shores of the Baltic and North Seas to the Persian Gulf. This was to be formed by the confederation of the German Empire, Austria-Hungary and the Balkan States, with suzerainty over Turkey and Persia. There is little doubt that both these eastern countries would soon have found themselves annexed by this powerful Pan-German State if the German dream of empire had materialized.

In order to carry out this idea, Germany commenced diplomatic and commercial activities with both Turkey and Persia. With Turkey the success was great. In a short time the Turkish army and navy had become Germanized in method and officers. Concessions for the building of railways and other commercial enterprises were secured.

The *Anatolian railway* was built with German capital and by German engineers. It commences at Haidar Pasha, a new port which was made opposite Constantinople. From here it runs first south, and then south-east to Konia. A branch runs east from Konia to Angora. This line was made the same gauge as the railway line which comes down from Germany through Vienna, Bratislava, Budapest and Belgrade into Constantinople. The reason for this was to allow trains to be ferried across the Bosphorus and so do away with the necessity of trans-shipment.

The Bagdad Railway is a continuation of this Anatolian railway. The Germans applied for a concession from the Persians to build a railroad right down to Basra. The granting of this concession was bitterly opposed by the British, who feared German designs on India. The result was that the Germans obtained a concession for a railroad as far as Bagdad, while the British secured the concession from Basra to Bagdad. This retained the British control of the Persian Gulf. It also finally decided the popular name of the railroad, viz., the Bagdad Railway.

The Bagdad Railway proper, therefore, commences at Konia. It is constructed on the same gauge as the Anatolian Railway. From Konia the line runs south, crossing the Taurus Mountains by the gap known as the Cilician Gates. It descends to Adana on the Cilician plains. Near here it branches, a short line running south to the port of Alexandretta. The main line passes through Aleppo, crossing the Euphrates River at Jerablus. It is at present stopped at Nisibin. From Bagdad a line is being constructed northward to meet the Nisibin section. This northward extension had reached Samarra, 75 miles from Bagdad, before the war. Since the war the British have extended it 58 miles farther. It is now (1925) a few miles north of Tekrit. It

will eventually link up with the Nisibin section at Mosul, thus completing the original German concession. The disturbed state of this section of Iraq, owing to the dispute with Turkey re the status of Mosul, has been the cause of the construction being suspended.

With regard to the British concession, obtained from Persia, to construct a railroad from Basra to Bagdad, it does not appear that any construction had been undertaken up to the time the Great War broke out.

During the Mesopotamian campaign the British military authorities constructed several light railways for their own purposes. Soon after the war most of these were taken up, and a permanent standard gauge railroad has now been completed between Basra and Bagdad. This line follows the right bank of the Euphrates River to Hilla. Here a train ferry gives connection with a line which runs south from Bagdad to the left bank of the Euphrates opposite Hilla.

Bagdad is now quite an important railway centre, lines running north-east to the Persian frontier near Khanikin, and north-west to Fellujah on the Euphrates. It would appear that the object of the line towards Persia is to link up the existing railroad from Batoum, Tiflis and Tabriz and perhaps to link Teheran with Bagdad and Basra.

From Aleppo a line runs south via Damascus, Kalat, and Medina, with a proposed extension having for its object the carrying of Mohammedan pilgrims to their sacred city of Mecca.

295. Trade Routes of India and China. The size and daring of the transportation projects discussed in the three previous sections make a very strong appeal to popular imagination.

These projects have received a further considerable amount of publicity from their close connection with many great political events of the world since the Russo-Japanese war. Another factor which keeps them well before the public is the British people's rooted objection to anything which savors of an attempt to undermine Great Britain's prestige in India.

This publicity should not be allowed to overshadow the great geographical fact that the real centre of Asiatic trade does not lie in the regions served by these projects.

The topography of Asia is of such a nature that the continent is divided into two unequal areas, one of which is far too arid and cold as well as too remote from the sea ever to support dense populations. This is by far the larger area. It is, however, badly served by natural aids to communication. Indeed, nature ceems to have most deliberately shut off this region from free access to the rest of the world.

Its great rivers drain into either an ocean or a sea which is ice-bound for many months in the year. Again, this area is

shut off from access to the sea in the opposite direction by an almost continuous stretch of deserts, plateaus, and mountains, which make up the centre of Asia.

The other area is radically different. It is the home of more than half the human race. Its products are varied and valuable; its populations dense; and its peoples many. Its natural lines of communication to the sea are, for the most part, abundant and well distributed throughout the region. These natural trade routes are mainly its great rivers, which all empty into seas ice-free the year round. They have been discussed in section 290.

These areas should be carefully considered by a close study of the map of Asia. The approximate dividing line may be obtained by ruling a line from Harbin in Manchuria to Calcutta in India, and then following the westward sweep of the Himalayas, the Suliman and Hala Mountains to the coast near Karachi in North-West India.

To the south and east of this line lies a region of great commercial importance, which is, however, only a promise of the still greater importance it is destined to have in the future. This region, it will be seen, comprises the peninsulas of India, Malaya, Cochin-China, and Korea, together with the island empire of Japan and the East Indian Archipelago. There is little doubt that this is to be the great theatre of commercial expansion during the immediate future. It only requires the building of railroads to bring about tremendous industrial and commercial expansion here.

296. Indian Railways. The principal Indian railways are:

(1) The East Indian Railway. This line commences at Howrah, opposite Calcutta on the Hugli. It runs up the Ganges Valley to Ambala in the Punjab. It passes through Patna, Benares, Allahabad, Cawnpore, Agra, and Delhi. It has many side-feeders or branches. Rice, wheat, cotton, opium, oil seed, indigo, etc., are the principal items of freight brought down to Calcutta.

(2) The North-Western Railway. This line continues the East Indian Railway across the Punjab to Peshawar, the great fortress guarding the Khaibar Pass. En route this line passes through Amritsar, Lahore, and Rawal Pindi. Lahore is the great railway centre of the Punjab. From Lahore an important branch runs to Karachi via Multan. This latter place is the great collecting centre for the Punjab wheat.

About half-way between Lahore and Karachi the line is joined by an important military line which runs through the Bolan Pass to the military towns Quetta and Chaman, which guard the lowest and easiest entrance to India from the north. This line is continued east to Duzdap in Persia. Thus there is only a small

gap separating it from the terminus of the Trans-Caspian Railway at Kushk on the northern frontier of Afghanistan. There is no really difficult engineering required to connect these lines, but it is hardly likely that this will be done, the political hazards being regarded as too serious.

(3) The Great Indian Peninsula Railway has two lines connecting Bombay with Calcutta and another which links Bombay with Madras. They are very important in reducing the time for the European mail and passengers wishing to go direct to Calcutta or Madras. They also bring down cotton, wheat and oil seed from the Deccan to Bombay.

(4) The Madras Railway runs along the east coast to Calcutta. It has also a branch line running to Calicut on the west coast of India. It is a great collecting line for tea, cotton, coffee and tobacco.

(5) The Central Indian Railway runs from Bombay to Delhi via Surat, Baroda, Allahabad and Jaipur.

In Burma there are two lines, the one from Rangoon through Mandalay and Bhamo to the Chinese frontier being very important. It collects rice, teak, petroleum and tin. The other line runs from Martaban through Mandalay to Katha. Its freight is similar to that of the line from Rangoon.

Ceylon is connected with the mainland by rail and steamer ferry running from Dhanushkodi Point on Rameswaram Island and Talaimannar in Ceylon. This connects with the railway line which runs from Jaffna at the extreme north of the island via Kandy and Colombo to Matara at the southern tip.

297. Railways of China. The railway development of China has only just begun. There is little doubt that as it is extended the already great volume of trade with China must be enormously increased. The principal Chinese railways are:

(1) The South Manchuria Railway from Changchun to Dairen, 693 miles.

(2) Pekin-Mukden line 604 miles.

(3) Pekin-Suiynan Railway from Pekin to Kalgan, Tatung Fu, Fengchen and Suiynan, 814 miles.

(4) Pekin-Hankow Railways, 814 miles.

(5) Lun Hai Railway from Hsuchowfu to Kwan-Yin-Tang, 359 miles.

(6) Shanghai-Nanking Railway, from Shanghai to Nanking, 203 miles.

(7) Tientsin-Pukon Railway, 686 miles.

(8) Shanghai-Hangchow-Ningpo Railway, 164 miles.

(9) Hupeh-Hunan Railway from Wuchang to Hochow, 252 miles.

(10) Kiaochon-Tsinan Railway from Tsingtao to Tsinan, 280 miles.

(11) Yunnan Railway, from the Tonkin border to Yunnan-fu, 290 miles.

(12) The Chinese Eastern Railway, from Manchuli through northern Manchuria to Progranichnayo, where it joins with the Trans-Siberian lines and connects with Vladivostock. From Harbin it sends down a branch to Changchun where it joins the South Manchuria Railway. This railway was built by the Russians and is to all intents and purposes a branch of the Trans-Siberian Railway. It runs for 1,100 miles in Chinese territory.

The total mileage of Chinese railways is very small for the size of the country and its population. It roughly works out to about one mile of railway to every 50,000 persons. Compare this with Canada's quota of one mile of railway to every 227 persons.

The case of Chinese roads is even worse. There are, of course, many thousands of miles of roads and trails, such as they are. But at the end of 1922 there were only 1,588 miles of improved public roads. With such poor railroad and highway communications, the question arises, how do the Chinese carry on their great internal trade? The answer is, by river and canal. No other country is the world has such a network of canals and navigable rivers. J. H. King, in his book *Farmers of Forty Centuries*, describing the canals of China, says a conservative estimate would place the mileage of canals and leveed rivers in China, Korea, and Japan at fully 200,000. He further says, "Forty canals across the United States from east to west and sixty from north to south would not equal, in number of miles, those in these three countries today. Indeed, it is probable that this estimate is not too large for China alone."

298. Transportation in Japan. The topography of Japan forces the people to live near the coast. The smallness of the islands and their narrowness have rendered great road-building projects unnecessary. The coasting boat has always been the great carrier of Japanese freight. Prior to the building of railroads connecting the principal centres, the inland passenger communication was by jinricksha. This is a light two-wheeled carriage with shafts, propelled by two men, one of whom pulls in the shafts and the other pushes behind. The jinricksha is disappearing, its place being taken by horse-drawn vehicles and motor cars.

Trade Routes of Africa.

299. The Handicaps to American Trade. As regards commerce and internal development, Africa is, taken as a whole, the most backward of all the continents. In view of its nearness to Europe and the attention it has received from explorers, this seems surprising. There are several reasons for this state of affairs, viz.:

(1) The three centres of greatest activity lie at the three extreme corners of the continent. This prevents internal trade between them.

(2) The extreme regularity of its coastline. There are no great penetrating arms of the sea to give easy access to the interior. The lack of bays causes a scarcity of good harbors.

(3) The build of the continent. The principal feature of the continent is the great interior plateau. This plateau occupies practically all the continent from the Sahara Desert south to Cape Colony, and from Somaliland on the east to the Atlantic on the west. Africa is bordered on the west, south, and east by narrow coastal plains. South of the Equator the continent maintains an average height of about 3,000 feet, often rising to more than 5,500 feet as, for example, at Johannesburg in the Transvaal, which is 5,960 feet above sea level. This plateau structure of Africa greatly hinders the commercial development of the country. On the plateaus the rivers are navigable for great distances, but on their way to the sea they must descend the steep slopes of the plateau in order to reach the coastal plains. In consequence their lower courses consist of rapids and waterfalls, which are of such a nature as to be an effective bar to navigation. Then, again, these steep slopes present considerable difficulty to the railroad engineer, causing expensive construction and high operating costs.

(4) Both to the north and south of the Equator, Africa contains great trade-wind deserts which greatly handicap trade.

(5) In the tropical region there are long stretches of unhealthy coast lands on both sides of the continent, but especially so on the west. These regions are so unhealthy as to prevent white people settling there and often from even landing there. It should be remembered, however, that once out of the basin of the Congo, which occupies a depression on the plateau, the unhealthiness disappears with the increasing altitude.

(6) The Equatorial Rain Forests. These immense tangles of luxuriant and exotic vegetation, together with the swampy nature of the ground, make road construction almost impossible through a large area of the continent.

(7) The backward condition of the black race which constitutes the major proportion of the population.

It will be seen, therefore, that the geographic conditions of build, outline, climate, vegetation, and race all combine to present an unfriendly front to the advance of trade on the continent. But conditions are greatly improving. The African forest produces many things required by modern civilization (nuts, oils, fancy woods, etc.); minerals are being discovered; medical

science is conquering disease; and the engineer is overcoming the transportation difficulties. In short, Africa is slowly being conquered by civilization.

300. The Cape-to-Cairo Railway. This stupendous project was conceived by Cecil Rhodes, the greatest of all South African statesmen. It was his lifelong purpose to link the British possessions in Northern Africa with those of South Africa. This he proposed to accomplish by building a railroad between them, which should run along the high, healthy plateau mentioned in the previous section. He also endeavored to induce the British Government to secure a continuous succession of British dependencies through which this railroad could be run. In this he was not successful, the German occupation of what is now known as Tanganyika Territory proving to be the great stumbling block. He could make no satisfactory working agreement with the Germans with regard to the Cape-to-Cairo railway project. The line was, therefore, swung around into the Congo Free State. At the time of his death his dream of an "all-red" strip from the Mediterranean Sea to Cape Town was not realized. But the events of the great war changed the conditions, and Tanganyika Territory was placed under British control. This has almost realized Rhodes' great dream, there being now a continuous band of British territory from Cape Agulhas to Wady Halfa, near the second cataract of the Nile. The granting of Egyptian independence resulted in the most northerly section being removed from British control. The southern end of the line links up with the railroad system of the Union of South Africa. These South African lines have three major terminals at the ports of Cape Town, Port Elizabeth and Durban. The main line runs from Cape Town via De Aar Junction where it is joined by the line from Port Elizabeth. From there it passes through Kimberley to Fourteen Streams, where it is joined by a branch line from Johannesburg. Still bearing north, it proceeds to Mafeking. Here it is connected via Johannesburg with Durban and via Johannesburg and Pretoria with Lorenzo Marques on Delagoa Bay. Pushing still northward through Rhodesia, the main line reaches Bulawayo. From this city it forks, a branch proceeding eastwards through Portuguese territory to Beira, while the main line runs north-westerly to Victoria Falls on the Zambesi. The river is crossed in sight of the falls by a fine bridge, and continues in a generally northward direction through Broken Hill to Bukama in the Congo Free State, a distance of 2,700 miles from Cape Town. From Bukama on the Congo, steamboats run to Congolo, 400 miles down stream. Here another railroad connects with Kindu, 217 miles away; and then another river trip on the Congo to Ponthierville has to be made. A railroad 77 miles in length extends from Ponthierville to Stanleyville. Here a railroad is under construction to Mahagi on the west short of Lake Alberta, 683 miles farther on. In the meantime an automobile road is used

to cover this stretch. From Mahagi a lake and river trip down the lake and White Nile for 1,163 miles brings one to Kosti, where the Soudan railway has its terminus. This railway carries one to Wady Halfa. The Nile steamers are again used for 200 miles to Assuan, where the trains of the Egyptian Railway may be boarded for the final trip to Alexandria. The project is, therefore, far from being completed. It is, however, possible to make the trip by the combination of lake, river, auto, and rail sections. The full trip occupies about eight weeks. There is little doubt, however, that the line will eventually be completed. But this route will never become a great transcontinental freight route. The distance, approximately 7,000 miles, is too great for that. Its chief function will be to connect the short lines which are even now being built or projected to reach it from the east coast ports. Of these lines there are five already built, viz.:

(1) The line from Delagoa Bay through Johannesburg to Mafeking.

(2) From Beira to Bulawayo via Salisbury.

(3) From Dar-es-Salaam to Ujiji on Lake Tanganyika.

(4) From Mombasa to Port Florence on Victoria Nyanza.

(5) From Port Sudan to Atbara on the Nile.

301. The Congo Route. The Congo is the greatest highway in Central Africa connecting with the west coast. The Congo is one of the world's great rivers, and with its many navigable branches performs great service to the trade of the region. It is, however, far from being a satisfactory river for the purpose. The reasons are:

(1) The great rapids and falls, commencing at Mahadi, less than 100 miles up the river from the port of Banana at the mouth. These necessitated the construction of an expensive railway, 250 miles long, in order to carry freight past them.

(2) In the middle course of the river there are two other long stretches of falls and rapids, also requiring railroads to avoid them.

(3) The river makes a great half-circle from the head of navigation to the sea. This makes the route very long. Compare its course with the St. Lawrence or the Amazon in this respect and note the difference between them.

(4) It fluctuates greatly in depth from season to season.

(5) Freight passing between Katango (where the great copper mines are) to the sea has to be handled sixteen times.

The chief articles of down-river freight are rubber, ivory, palm nuts, and palm oil. The up-river freight consists mainly of cotton trade goods and metal ware.

302. The African Lakes. In Central Africa there is a great system of lakes, which is almost as large as the American Great Lakes. These lakes are navigated by steam boats and are connected by rail to the east coast. A line also runs from Kavirola on Lake Tanganyika to Kabalo on the Congo. Lake Tanganyika has, therefore, connections with both the east and west coasts of the continent.

303. The West African Railroads. The penetration of the West African region by railroads is progressing with great rapidity. Many railroad lines have been or are being built. The region is densely populated and is rich in those oily nuts which are becoming so increasingly valuable as a source of oil.

In Nigeria there are 1,265 miles of railway open. A new trunk line has been recently constructed from Port Harcourt to the Enugu coalfields (151 miles).

In Ashanti there is a railroad from Seccondee on the coast to Coomassie. Coomassie is also connected by rail to Accra, another port on the Ashanti coast.

Sierra Leone has a railway connecting the port of Freetown with Pendembu (227½ miles). A branch line runs from Boia Junction to Kambai (104 miles).

Further extensions are in contemplation and a great increase in the trade of the region is expected.

304. Caravan Routes. The formerly important caravan trade across the Sahara and Soudan Deserts is steadily declining. The French have connected Timbuktu with the port of Dakar at Cape Verde with rail and river steamers on the upper reaches of the Niger River.

There is also considerable experimenting with caterpillar automobiles with a view to connecting Timbuktu with Algiers. The Algerian Railway (French) has crossed the Atlas Mountains and is ousting the caravan from that region. The caravan, however, is holding its own in the Central and Italian Sahara as well as in the Lake Chad region.

South American Trade Routes.

305. Geographic Barriers to Commerce. South America presents many geographic obstacles to the development of trade routes. These may briefly be summed up as:

(1) The nature and position of the Andean Mountain Chain, which presents an all but impregnable front to the attacks of the railroad engineer.

(2) The plateaus of the north-east and east portions of the continent. These hamper commercial development for much the same reasons as those considered with regard to the African Plateau.

(3) The extreme unhealthiness of the coastal lands north of the Tropic of Capricorn.

(4) The immense area of tropical forest an dswamp comprised in the basins of the two most navigable rivers—the Amazon and the Orinoco.

(5) The presence of the great coastal deserts of Peru and Northern Chile.

(6) The generally regular nature of the coastline.

(7) The lack of great coalfields to provide cheap fuel as a source of motive power.

All these things together constitute a problem in transportation which is requiring the application of the very highest type of engineering skill to solve.

306. Traffic of the Great Rivers. On looking at a map of South America we see three great river systems, the Orinoco, Amazon, and La Plata. At first it would seem that these mighty rivers should carry an enormous burden of commerce. The courses are relatively direct; they all have an almost constant volume of water; and they are deep and easy to navigate.

These fine rivers, however, are at the serious disadvantage of penetrating that portion of the continent which, owing to its dense forests, swampy lands, and unhealthy climate, is least suitable for settlement and vigorous development. In consequence we find that although these rivers carry an important volume of freight, they do not take so relatively high a position as commercial highways as such rivers as the St. Lawrence, the Rhine, the Danube, the Yangtse-Kiang, and many others whose valleys are more favorable to settlement.

The Orinoco is navigable for ocean-going steamers as far as Ciudad Bolivar, about 300 miles up the river. River steamers ascend to the rapids at Atures, about 1,000 miles farther up. In addition, a great number of its tributaries are fine navigable streams. Most of the freight borne down the river is taken by these small steamers to Port-of-Spain on the Island of Trinidad, which forms a great collecting and distributing port for the region.

The Amazon. This is without question the finest navigable river in the world. Ocean-going steamships of 15 feet draught can ascend the stream, without a pilot, to the port of Iquitos in Peru. This is approximately seven-eighths of the total distance across the widest part of the continent. Iquitos is almost 2,000 miles from the Amazon's mouth. Besides this main trunk, no other river has such a large number of navigable branches. It is claimed that there are at least 15,000 miles of navigable waterways in the Amazon basin. The Amazon receives considerable freight from eastern Bolivia and eastern Peru. Its ports of Para, at the mouth, Santarem, about 400 miles upstream, and Manaos, about 850 miles from the sea, are regularly visited

by lines of British steamships. But despite these great natural advantages, the region is very poorly developed. The climate of the basins of these rivers is far too unhealthy to allow of European settlement. The denseness of the vegetation makes the construction of roadways difficult, while the quickness of its growth makes it difficult to maintain them.

The Rio de la Plata. The Rio de la Plata is not really a river. It is a broad, shallow estuary receiving two large rivers, viz., the Parana and the Uruguay. The Parana and its tributaries are navigated by river steamers for upwards of a thousand miles beyond Buenos Aires. These fine waterways provide the routes over which is transported the commerce of Northern Argentina, parts of Paraguay, Uruguay, and Southern Brazil. The ocean going vessels coming into the Rio de la Plata for grain ascend the Parana to Rosario, 230 miles above Buenos Aires. Rosario is one of the principal grain-exporting ports of the world.

The attention of the Argentinians has been temporarily diverted from the development of this fine waterway by an era of railroad building. The water route is, however, beginning to receive attention again, and the combination of river and rail transport in the Argentine will further increase the already fine transport facilities of this region.

The Magdalena River. This fine river of Colombia provides the principal trade route into the interior of the republic. Its mouth is so silted up with sand, however, that it cannot be used by ocean-going steamers; hence its river port of Barranquilla is connected by a short railway line with Savanilla. The other seaport, Cartagena, is also connected with the river port at Calamar by a railway. The steamers plying on this river are of the familiar stern-wheel, flat-bottom type seen on Canadian rivers. The total length of navigation on the main stream is about 900 miles, with an additional 200 miles on the branches. About 600 miles from Baranquilla rapids occur, which require a fourteen-mile railway to pass them. The side traffic to the river is accomplished by short lines of railway or by pack trains of mules. This necessitates a specialized type of manufactured articles for the Colombian trade, since no greater weight than 100 pounds can be carried over the wretched trails, called roads, to the interior towns.

307. The Railways of South America. In general the railroad development of South America is poor. Small railroads exist, however, in every country of the continent except French Guiana. These small lines penetrate for short distances inland from a large number of ports, which it is their function to feed. Except in Argentina, Uruguay and South-Eastern Brazil there are no well-organized internal trading routes focussing upon great collecting ports, such as we see in the case of Montreal or New York in North America, and Antwerp, Hamburg, or Stettin

in continental Europe. This condition produces a large number of seaports, most of which are insignificant, and served by railway systems which are also little known.

On the other hand, in Argentina, Uruguay, Chile and those parts of Brazil where the conditions are favorable, there is a splendid system of railroads. These four states are the most progressive of the South American Republics, their advancement being, in no small measure, due to the organization of their internal trade routes.

308. The Chilean Railways. The organization of the inland transport of Chile presents a very difficult problem. The difficulties are all geographical. They may be summed up as:

(1) The enormous disparity between the length and breadth of the country.
(2) The great mountain barrier of the Andes.
(3) The great desert region of the north.
(4) The fiord region of the extreme south.
(5) The lack of navigable rivers.

The Chileans are a progressive people and have struggled hard to solve this problem. Successive Chilean governments have steadily carried out, for the benefit of the nation, a fine national railroad policy. The result of this policy is the long backbone of railway which runs from Puerto Montt (where the fiorded region begins) to the great nitrate ports of the far distant north. From this great longitudinal line many branches, east and west, serve the great ports and penetrate the foothills of the mountains.

Three lines climb right over the Andean barrier:

(1) The long line of railroad from Antofagasta through the nitrate-mining, copper-mining, and borax-mining regions into Bolivia.
(2) The Arica-La Paz Line. This was built by the Chilean Government in accordance with the treaty made with Bolivia after the War of the Pacific. The purpose of the line was to provide Bolivia with access to the sea.
(3) The Trans-Andean Railway. This is, perhaps, the most spectacular feat of railroad engineering that has ever been achieved. It is a short line, 111 miles in length, built to connect the Buenos Aires-Pacific Railroad at Mendoza with a spur of the longitudinal railway of Chile at Los Andes. This Trans-Andean link is of smaller gauge than either of the lines which it joins together. This necessitates trans-shipment at both these points.

The engineering difficulties surmounted are amazing. The task of keeping the line open, especially in the winter and spring, is very arduous. The grades are so steep that the rack and pinion method of haulage has to be resorted to in several places. The summit of the Andes

is pierced by a tunnel 10,384 feet long and 10,778 feet above sea level. Note the great altitude. Connaught Tunnel on the Canadian Pacific Railway is 3,791 feet above sea level at the Glacier portal. The Andean tunnel is 3,500 feet higher than any of the great Alpine tunnels of Mont Cenis, St. Gothard or Simplon. Besides this summit tunnel there is another one on the Argentinian side, 5,325 feet long. Between the two tunnels is a great gorge which is crossed by a steel bridge. The descent on the Chilean side is accomplished through a series of spiral tunnels, in all 27,840 feet long.

In passing through these tunnels the line covers a difference in altitude of 2,762 feet in the short distance of 27,840 feet. The railroad engineer has thus brilliantly succeeded in providing passenger and mail communication between Valparaiso and Buenos Aires. The problem of inland freight transport between them, however, remains to be solved. The fearful grades and the high expense of operation effectually prevent a large freight movement across the Andes. Some freight is still carried by pack train over the Uspallata Pass, 2,000 feet above the railroad tunnel, this method being cheaper than by the railroad. By far the greater part of the freight movement between the two coasts, however, is carried by coasting steamers through the Straits of Magellan.

309. The Argentine Railways. The railroad development of Argentina has been phenomenal. Railroad construction commenced in 1857 with a small State-owned line running out of Buenos Aires. Eight years later, in 1865, there were only 150 miles of railroad. Thirty years after, that is, by 1895, the total mileage had only reached 8,820 miles. By 1905 it totalled 12,370, whilst in 1913 it had reached 21,340 miles. That is, it nearly doubled in eight years. Owing to war conditions and the general financial confusion during the period of reconstruction, the further expansion of these lines has been suspended. But this condition is only temporary. The vast potentiality of the Argentine as a producer of food material, and the ease of railroad construction, make it certain that before long there will be a revival of railroad expansion. There seems little doubt that, when this occurs, the rapid expansion of the eight years preceding the Great War will be at least paralleled, if not exceeded. By far the greater part of this railroad expansion has been accomplished by British engineers with British capital. The State-owned mileage is about 4,200 miles. The greater proportion of the railroad mileage of the country is included in the elaborate network of lines which converge on the great ports of Buenos Aires, Rosario and Bahia Blanca. The closely knit network of lines in the province immediately surrounding these three ports is astonishing. These lines are splendidly equipped with locomotives and rolling stock. Their port terminal facilities will

bear comparison with those of any system in the world. Over these lines are carried immense numbers of cattle and sheep to the great slaughtering and refrigerating plants of the ports. In addition, the railways bring down immense quantities of wheat, corn, sugar, wool, wine, etc. The passenger traffic, except in the suburban regions of the great cities, is surprisingly light.

Besides these great terminal centres of railroading there are several inland points towards which the railroads converge, thus producing important inland railroad centres. Of these the most important are Cordoba and Santa Fe in the central north, Mendoza at the extreme west, and Tucuman, the great sugar centre of the far north. In addition to the closely knit pampas lines there are long trunk routes which give railroad connection with the neighboring republics of Uruguay, Paraguay, Bolivia and Brazil. Argentina, therefore, with its twofold system of railroads and rivers, has its inland transportation finely organized. Its railroad mileage is equal to one mile of track for every three hundred and eighty persons. Argentina ranks ninth among the countries of the world in railroad development. As an indication of the importance of Buenos Aires as a railroad centre it may be stated that 500 passenger trains leave that city daily. Argentina has no coalfields and has only one small oilfield at Commodoro Rivadera; and the Pampas are treeless plains. The problem of fueling the railways is, therefore, a difficult one. The coal is mainly supplied from the British coalfields.

310. The Brazilian Railways. Coffee forms almost one-half of Brazil's total exports. The coffee-growing region is concentrated on a plateau along the south-eastern coast. It is, therefore, not very surprising to find that the greatest railroad development in Brazil is a complicated network of lines connecting this region with its two great ports of Rio Janeiro and Santos. There are also several geographical reasons for the lack of railway enterprise in the rest of the country. Some of them are:

(1) The great area of the country.
(2) The presence of the magnificent waterways of the Amazon system.
(3) The difficulty of railroad construction in an equatorial forest.
(4) The unhealthy climate of the low-lying lands of the Amazon basin.
(5) The sparsity of the population.

There are three chief fans of radiating railroad lines in Brazil. These converge on the ports of Pernambuco, Rio de Janeiro and Santos. The system converging on to Pernambuco is of great importance to the sugar, cotton, and tobacco-producing areas in the extreme eastern shoulder. It comprises about 1,100 miles of track linking up four states and serving the ports of Maceio, Pernambuco or Receife, Parahyba, Cabedello and

Natal. The fan consists of seven lines, three of which are state-owned, and four are British-built and are operated by British companies.

The Coffee Lines. These comprise the great systems radiating from Santos and Rio de Janeiro.

The Rio Fan. From the city of Rio de Janeiro an exceedingly important network of lines extends in all directions. Following the coast, the port of Victoria to the north is linked with Rio, while a southern branch gives railroad connection with Santos. The ascent to the plateau is made by means of a fine piece of railroading known as the "Petropolis Link." Here the ascent is so steep that it has to be accomplished part of the way by a rack railway. On the plateau the lines branch in all directions into the interior of the State of Minas Geraes, serving an important coffee, dairy, and mining region. It is connected at several points on the plateau with the Sao Paulo fan.

The Sao Paulo System. This is the busiest railroad system of Brazil. Here the lines are clustered together in a closely-linked network through the whole of the Sao Paulo State. This complicated net of railway lines centres in the city of Sao Paulo where connection is made with the port of Santos. This is accomplished by the Sao Paulo to Santos line, one of the best known of railroad lines. Down this fan handle pours the great bulk of the coffee used in the world. In 1915-16 seventeen million bags of coffee were sent to the sea via this line. It is only about eighty miles in length, but the engineering difficulties met with were enormous. It is electrically operated by a rope haulage of the "endless chain" type. The care taken of this line is world-famous. It is said that a very prominent American railroad engineer was taken over the line some years ago. He was asked if he could suggest any improvements. His reply was: "Not unless the ends of the ties could be carved or the rails set with diamonds." As an example of the engineering skill required it may be stated that on one of the steepest grades the line climbs 2,500 feet in a distance of six and a quarter miles. This is a British-built line, operated by a British company. It is said to make greater profits than any other line of railway in the world. From Sao Paulo a long line penetrates westward to Porto Esperanca on the Paraguay River. Here river boats connect it with the Argentinian railroads at Corrientes. Another line runs southward through Curityba to Rivera on the Uruguay boundary. Here it completes rail connections with Montevideo and Buenos Aires by the Uruguayan and Argentinian railways.

From Curityba this long southern branch is connected with the east coast at Paranagua through a lateral branch. Other lateral lines branch off at Santa Maria for Porto Alegre and from Cacequy to Rio Grande-de-Sul.

From Entroncamento a lateral to the west connects the main line with Uruguayana at the extreme south-west tip of Brazil. Here another route to Montevideo and Buenos Aires commences.

311. Commercial Isolation of Pacific South America. The Pacific coast of South America is, perhaps, the most isolated of all the world's commercial regions.

Prior to the opening of the Panama Canal the situation was about as bad as it could possibly have been. The opening of the canal has very materially relieved the situation, but the isolation is still a very serious factor. Summing up the conditions, we find the following chief reasons for its isolation:

(1) The stupendous mountain barrier of the Andes. The great height of these mountains and the absence of easy passes or gaps practically isolate the Pacific countries from the rest of the continent.

(2) The baffling winds, the pressure of icebergs, and the dangerous character of the navigation through the Straits of Magellan greatly restrict trade movements in that direction.

(3) The high tolls of the Panama Canal have the effect of greatly raising the freight rates between this region and the manufacturing centres of the world.

(4) The scarcity of good harbors hampers shipping activities along this coast.

(5) The rugged hinterland makes it very difficult to organize internal communications in such a manner as to concentrate the products in a few great ports.

(6) The region lies off the main path of the great oceanic highways of trade.

(7) The parts nearest to the great markets of the world are the least progressive, have the poorest climates, and are the most difficult to develop.

Against these disadvantages we must set out the advantages of the region. These may be stated as:

(1) The wonderful mineral wealth. Here, and here only, is found the valuable "Chile Saltpetre," upon which so many of our modern industries and the fertility of our great agricultural areas are dependent. Oil is very abundant and of easy access to the sea.

(2) Many tropical vegetable products of high value are obtained from this region.

(3) The awakening of the people, who are now throwing off the heritage of a peculiarly vicious past and swinging slowly into the march of modern progress.

(4) The ability and commercial aggressiveness of the populations in the south temperate section.

(5) The Panama Canal has brought about a saving of about fifteen days for a freight steamer between New York and Valparaiso.

These advantages will undoubtedly result in an attempt to improve the communications of Pacific South America with the

rest of the world, and it seems likely that the North American countries will receive a major share of any expansion of trade thus produced.

Trade Routes of Australasia.

312. Australia. The problem of internal communication in Australia is a very difficult one. The arid and semi-arid interior of the continent, and the monsoon climate of the north coast, have forced its centres of activities into two main regions. These are:

(1) East of a line which may be drawn from Rockhampton on the east coast to Adelaide on the south coast.
(2) The extreme south-west horn of the continent.

Here is concentrated by far the greater proportion of the population of Australia. Certainly it is within these two small regions that all her great cities are located. This is because of—

(1) The suitability of the climate to Europeans.
(2) The sufficiency of the rainfall.
(3) The nature of the soil.
(4) The presence of minerals.

These regions are separated from each other by as complete a desert as is found anywhere on the globe. The same desert prevents easy communication with the north coast. How terrible is the aridity of this region may be gathered from the statement that all the water required for the mining operations and for the townspeople of Coolgardie and Kalgoorlie is carried by a huge pipeline from the mountains behind Perth. This isolation is further accentuated by the absence of any great penetrating arms of the sea, and by the absence of navigable rivers. Except for some small navigable stretches on the Murray-Darling River system there is absolutely no inland water navigation possible on the continent.

Speaking broadly, the railroads of Australia occupy the coastal areas, the arid and little known centre of the continent being without railroad facilities. Except for a few colliery lines and one or two other minor railroads, the Australian railways are state-owned. Ownership of some is invested in the Commonwealth and others in the governments of the individual States. Prior to the inauguration of the Commonwealth on January 1, 1901, much railway construction had been accomplished by the separate States. Unfortunately these States built their lines with little reference to what was being done in other States. In consequence, Australia finds herself with a legacy of railroads of widely varying gauges. This condition militates against the efficiency of Australian railways as carriers of through freight. At every State boundary trans-shipment of passengers, mail, and freight is necessary. This results in added expense, delays, and high breakage charges, to say nothing of annoyance. Queensland has by far the largest railroad mileage, pushing long lines

far into the interior over the Eastern Australian Highlands from the ports of Rockhampton, Townsville and Cairns, as well as connecting these ports with the capital, Brisbane. In the south-eastern part of Australia there is now a fairly dense network of railways converging on the great ports of Brisbane, Melbourne and Sydney. The south is well served by four main lines running out from Melbourne. The many branches from these trunk lines provide excellent railroad facilities for freight movement to this large port. From Adelaide one main line runs north for nearly 700 miles to Oondata. This the Commonwealth Government has pledged itself to link up with the Northern Territory line now running a short distance south from Port Darwin to Katherine River. At present mail and passenger connection is obtained between these two points by aeroplane, there being a regular air line service between these places. Several branch lines run to the coastal towns from points along this Adelaide-Oondata line.

Melbourne and Adelaide are connected by a broad-gauge through line. Another railway runs from Adelaide in a south-east direction connecting with the main line from Melbourne to Adelaide on the South Australian-Victorian border near Serviceton.

Western Australia has over 4,900 miles of railway lines, which radiate from Perth, linking it up with the ports of Geraldton, Fremantle, Bunbury, and Albany, and with the Trans-Australian line at the great goldfields of Kalgoorlie.

313. The Trans-Australian Railway. The Trans-Australian Railway was constructed and is owned and operated by the Commonwealth of Australia. It connects Kalgoorlie in Western Australia with Port Augusta, and is of standard gauge, viz., four feet eight and one-half inches. It is remarkable for having on the Nullabor plains the longest piece of straight track in the world, viz., 300 miles without a curve. The line provides railroad communication between Perth in Western Australia and Brisbane in Queensland. It is necessary, however, to change trains eight times. The time occupied in making the journey is five days ten and a quarter hours from Perth to Brisbane.

314. New Zealand Railways. In this country the railroad engineer was faced with difficulties of an exceptional kind. Passing down the centre of each of the two main islands forming the country there are great mountain ranges, quite the equal in height and grandeur of the Rockies. Whenever he tried to leave the coast he was faced with this great barrier. The amount of freight to be carried and the relatively short haul made it almost impossible to build a line which would have the remotest chance of paying for itself. The rugged relief of New Zealand makes the number of bridges one of the striking features of its railroads. Auckland, the principal port of the North Island, is connected with Rotorua, the great geyser and hot lakes region.

In the South Island, Christchurch is the centre of the system; from here a line goes across the island to Greymouth. Another creeps round the coast, south to Dunedin and Invercargill. Numerous branches fan out from these two points to the great sheep and cattle ranges behind them.

315. Trade Cnnections of Australia and New Zealand with the Rest of the World. These two countries lie half the circumference of the world away from their principal markets, Great Britain and the United States. They are, therefore, the termini of the great ocean routes which reach them. These routes are:

The Mediterranean Asiatic Route, which reaches Australia by two branches, a principal mail route leaving the great trunk at Ceylon and reaching Fremantle where it connects with the Trans-Australian Railway. The other is a smaller branch leaving the trunk line at Singapore and reaches Brisbane and Sydney via the Torres Straits.

The main freight route, however, is the Cape of Good Hope Route. This carries by far the greater proportion of the Australasian freight. Another mail route is via the Panama to Liverpool and New York, but this is not so busy as the others. The greater proportion of the mail and passenger communication is via the Canadian or American railroads through the ports of Vancouver and San Francisco. A considerable amount of New Zealand freight passes with the favorable west winds around the Straits of Magellan and then north through the Atlantic Ocean to Liverpool and London. Little freight is ever moved across the middle of the Pacific Ocean from these lands. This may seem surprising to many, but a moment's study of the globe will convince one that the shortest route from Australasian ports to the South American side of the Pacific Ocean or to the Panama Canal is not that given by sailing directly across the ocean. The shortest route is obtained by following a southward swinging curve. Use the globe when considering routes. The flat map gives the most perverted ideas of distance. Remember also the great circle factor, which will be discussed in the topic, Great Circle Sailing.

Ocean Trade Routes.

316. We have already discussed the importance of the ocean as a highway for commerce. We have considered the reasons why ocean transportation in comparison with land transportation is so cheap.

We have now to consider in detail the great sea lanes along which this ever-increasing burden passen. The most superficial study of the sailing lists will reveal the fact that the great bulk of the ships travel along definite routes in their business of carrying passengers and freight up and down the world.

That is to say, just as we have great trunk railways passing from point to point on the land, so we find that there are great trunk steamship routes across the ocean. Along these routes pass the three great classes of carriers:

(1) The Ocean Liner.
(2) The Tramp or Charter Steamer.
(3) The Sailing Vessel.

Owing to the demand for rapidity and certainty of time of delivery, the sailing vessel is rapidly declining in importance. Her last stronghold is in the belt of the Roaring Forties of the Southern Hemisphere, where the geographical conditions are most favorable to her.

Official statistics give the following distribution of the world's merchant shipping as at July 1st, 1922:

	Vessels	Tonnage
Steam-driven and Motor-driven	29,246	62,335,373
Sailing Vessels	4,261	2,830,865
Total	33,507	65,166,238

The above figures are from Lloyd's merchant register for 1923-4. The British Empire, according to the above authority, owns 11,135 vessels having a tonnage of 22,058,112, or more than one-third of the total tonnage of the world's shipping.

The United States is the next great owner of shipping, its proportion being 5,415 vessels with a tonnage of 16,945,363 tons, being a little more than a quarter of the total.

The greater part of the tonnage of the United States shipping, however, it must be remembered, is engaged in coastwise shipping and on the Great Lakes.

The American-owned ships on the Great Lakes on the above date numbered 513 with a tonnage of 2,286,619 tons, or about one-seventh of America's total tonnage .

France makes a poor third with a total of 2,021 vessels having a tonnage of 3,737,244 tons, whilst Germany now (1925) ranks fourth with 1,843 ships and a tonnage of 2,590,073.

Let us now consider these classes of carriers and try to obtain some idea of the work in which they are engaged.

The above mentioned three classes of ships may for our purpose be divided into two types according to the traffic method which they employ to obtain freight. These types are called:

(1) The Line Traffic.
(2) The Charter or Tramp Traffic.

Nearly everyone is familiar with the "Ocean Liner." Her main business is the carrying of passengers, mail, and such kind of freight as can afford the high freight rates charged.

To use a land analogy, liners may be likened to the express, passenger, mail and fast-freight business of a railroad.

Owing to the amount of advertisement she receives in the press and by the placards in railway companies' offices and stations the liner bulks much more largely in popular estimation than the facts of transportation warrant. The fact is that as a carrier of freight she is far outdistanced in importance by the charter or "tramp" steamer.

Charter vessels are single vessels operating as unts, and they handle by far the larger portion of the ocean-borne freight. To use a land analogy again, the charter vessel is like a wagon or truck standing for hire on a city square. You wish to remove, say, some furniture, and you bargain with the driver, who is often the owner. By a purely individual arrangement between yourself and the driver the job is done and he is ready for another. Charter vessels, or, as they are more often called, "tramps," operate in the same manner. Just as a teamster or truck owner will oftentimes make his headquarters in some real estate broker's office so that he may be easily accessible to people requiring his services, paying the office owner a commission on calls received through his office, so the "tramp" is listed with some ship-broker's firm which secures freight for her on commission, and she goes about doing the world's carrying business unnoticed by the press or the travelling public.

The essential differences between the two types are—

(1) The liner must aim at regularity of sailing and reliability of service, and even if her hold is not full of cargo she must sail as advertised.

(2) The first essential of "tramp" service is cheapness, and the aim of the broker is to so move the ship from point to point around the world that she shall always sail with a full cargo. It is also important that she shall not be kept waiting for cargoes, since this means added expense.

One must always remember, however, that both types of shipping are essential to the world's commerce, just as the express train and the slow freight train are necessary to the efficient handling of traffic on shore.

The tramps handle the trade of vast quantity, the liners the trade of high value, and the small-size shipment which would not justify the chartering of an entire vessel.

The present trend of line shipping is toward the formation of main trunk lines of large steamers to which at suitable points, usually the ends, but in some cases at intermediate points as well, branch lines of smaller steamships act as feeders. This system of smaller feeding lines to the main trunk line routes has been forced upon great line companies by the insistent demands of the public for regularity and precision in sailing.

The tramp steamer, on the other hand, is a remarkably free agent, chiefly for the reasons that she is not chained to any particular route, and that she is often owned, at least in part, by her captain. She is free to go wherever freight offers. Owing to the freedom of the seas, she can take service in any of the seas

and carry the products of any country. She has, however, the one serious drawback that she can only be hired by those who can afford to load a whole ship. This forces the tramp into carrying certain lines of merchandise, viz., the bulky raw materials of commerce.

The principal cargoes for tramps, then, are grain (easily the first in importance), sugar, raw cotton, ores, coal, nitrate of soda, lumber, china clay, and petroleum. Besides these there are, of course, many other commodities, but the above mentioned are the most important. Now, scattered throughout the world are hundreds of ports with just such cargoes awaiting transportation by the tramps, and there are thousands of vessels scattered over the ocean to do the work.

The bringing of these together under the proper conditions, so that all the freight is carried, and the ships carrying it are operated so as to make the least possible number of voyages in ballast, is the great problem of the world's shipping brokers. It is one of the most complicated of problems, and without the ocean cable its successful solution would have been impossible. Nowadays, with the aid of wireless communication, the situation is much simplified and much easier than with the cable alone. Even so, it is a problem which can only be described as a world puzzle.

In order to assist in the solution of this most vital problem, Lloyd's Shipping Agency in Great Britain was established many years ago. This agency with its branches throughout the world reports every observed movement of more than 10,000 vessels. Other maritime associations of smaller size, in commercial ports, do the same kind of work, and by subscribing for their reports a ship owner may know where his vessel is and where those of his rivals are.

But to keep track of the vessels alone is not enough. An equally careful watch must be kept on the freight.

Most of the cargoes offering for tramp steamers are dependent upon two main conditions, viz., harvests and commercial conditions. The manager of a tramp steamer, then, must be a master of applied commercial geography. He must know the products of every region of the world, and the times of ripening and harvesting of the various crops. The climatic conditions of these regions together with their seasonal weather must be carefully studied.

The early knowledge, say, of a destructive frost, would enable him to switch his vessel to another port, or at least enable him to secure another type of cargo from that region without loss of time to his vessel.

He must know also the busy and slack times of every port. In this respect let us consider, say, Australia. Wool forms by far the greater bulk of the cargoes shipped from Australia; yet its movement is markedly seasonal, the greater part being ship-

ped between November and May. Obviously, the chances of picking up a cargo there during these months will be very much greater than at other times of the year.

He must, also, when making an arrangement for one voyage, take into consideration where it will place his vessel with regard to easily securing a cargo for her next voyage. If the port of discharge is one where the chances of securing cargo are small, then he must offset this disadvantage by increasing his freight rate sufficiently to enable him to move his vessel in ballast to some other point without loss.

The influence of possible cargo for the second voyage on the fixing of freight rates is well brought out in the cases of Port Said, Aden, Colombo, and Singapore, coaling stations on the Mediterranean-Asiatic Trade Route.

This route suffers from the disadvantage of having no coal-field situated near its middle points. The bulk of the coal for this route is carried by tramp steamers from Wales, South Africa, Australia, and Japan.

Port Said is the most important coaling station in the Mediterranean Sea. Here coal may be purchased cheaply, since the tramp which has delivered the coal can usually obtain a full cargo of grain or raw cotton in Egypt.

Aden is known as the most expensive coaling station on the route, for the reason that it is situated at a point where the hinterland is composed of two deserts, one on either side, so that cargoes are scarce. Therefore, since the tramp will have to proceed in ballast to the next port, freight rates are raised, and the price of coal along with it.

Colombo, on the other hand, is the outlet for the rich island of Ceylon and is also near such ports as Madras, where cargoes are certain. Therefore, freight on coal is correspondingly low. Singapore, lying at the end of the Malay Peninsula, round which all ships entering the Pacific must pass, and conveniently close to the rich rice fields of Burma and the sugar and rubber ports of Java, is a splendid place to pick up cargo. Here a vessel from Australia may deliver a cargo of coal and pick up a cargo of rice, sugar, manilla fibre, etc., for almost any place she may wish to go to.

From the above discussion you will see that the manager of the tramp must be a man of great business acumen and organizing ability and must perforce pay great attention to the study of the great geographic principles.

317. "Great Sailing Circle." There is another factor which operates in settling the location of main ocean trade routes, viz., "The Great Circle."

In order to fully understand the effect of Great Circle Sailing one must carefully examine a globe, because no flat map of the world can convey a correct idea of the distance between any two points on the earth over large areas.

If we, then, carefully examine a globe with a view to discovering the shortest distance between two points a considerable distance apart on the earth' surface, we shall find that the shortest distance between them is not a straight line but the arc of a circle whose centre is also the earth's centre, and which divides the earth into two equal parts. Such a circle is termed a "Great Circle."

Now on a globe we shall see that all the meridians of longitude are circles of this class, as is also the Equator. The parallels of latitude belong to another class of circles known as "Small Circles."

Let us now, with the aid of a piece of string and a globe, make one or two tests which will prove the truth of the above statement. Let us try, first, to discover the shortest distance between the great ports of New York and Liverpool.

Tie a piece of string into a loop just big enough to slip over your globe. Lay the loop over the globe so that it passes through New York and Liverpool. Now carefully adjust the string so that it will form a circle around the globe in such a manner that the globe is divided into two equal parts. This is our great circle. Now measure the distance between our two ports. Again lay the piece of string directly across from New York to Liverpool without regard to equalizing the hemispheres formed on either side of it. You will be astonished to find that the arc of the great circle is the shortest possible distance between these points, although it apparently runs in a more north and south direction than that in which these two places appear to lie with respect to each other.

Another astonishing fact which will be noticed is that the very shortest air line from New York to Liverpool does not follow the Atlantic Ocean at the beginning, but passes directly over land through New England and Canada west of Nova Scotia.

Now it will be apparent that the more closely ships can approach this great circle line the shorter will be their voyage. In consequence of this, as soon as it is possible, a vessel leaving New York will abandon its easterly course and turn northward along this great circle.

This has he effect of swinging all the shipping of the North Atlantic along a definite trunk route, and also of bringing the vessels leaving Montreal, Halifax, and New York very close together before they reach mid-ocean.

Now let us place another similar string loop over our globe with respect to Greytown in Nicaragua and Liverpool, taking care to adjust the loop right round the globe so that it will divide it into two equal parts. This, it can be proved by measuring, is the shortest air line between these two ports. It will be see that it runs very close to our air-line track across the Atlantic from New York to Liverpool, and vessels sailing between these ports will for some time follow the same trunk route as steamers from the other ports previously mentioned .

Other interesting measurements can be made which will further prove to you the truth of our statement that the shortest path between two points a considerable distance apart on the earth is that which is an arc of a great circle.

Try similar experiments on the Pacific Ocean and you will find some very curious facts as to the shortest distances between ports on the different sides of this ocean. For example, the shortest possible route from Panama to Yokohama goes northwestwards through the Caribbean Sea, Yucatan, the Gulf of Mexico, Texas, Wyoming, Vancouver Island, the Alaskan Peninsula and Japan. But a vessel cannot go overland, so it hugs the Pacific Coast of America until it reaches Southern California; it then crosses the Pacific, reaching about as high a latitude as that of Southern Canada.

These facts place San Francisco nearly on the shortest route between Panama and Yokohama. The usual Mercator map of the world distorts these facts, making it appear that Hawaii would be the natural port of call for vessels travelling between these points. This is, however, a mistake, for to stop at Hawaii would carry the vessel more than 300 miles off her course, whilst San Francisco only requires a deviation of 114 miles.

In their efforts to save time, ships' captains often sail very much closer to the true great circle line than safety considerations farrant, and many of our great marine disasters have been directly traceable to this constant effort to make quick voyages. The fearful catastrophe of the *Titanic* was in a great measure due to the desire of the captain and owners to institute a new time record for this trip. The continual hedging northwards towards the great circle in an endeavor to shorten the distance brought the ship into the iceberg zone and resulted in her destruction. On the North Atlantic route one of the great danger points is Cape Hatteras. This low sandy cape really juts into the Atlantic a much farther distance than appears on an ordinary flat map. In their efforts to save time, ship captains often skirt too closely the long strings of sandy ridges around this cape and so, yielding to the temptation to save time, many a good ship has been lost. Remember, then:

(1) That the shortest sailing distance between two ports is not a straight line measured directly across a flat map, but is to be represented on such a map by a curved line.

(2) That the di:erence in distance is greatest in high latitudes.

(3) That great circles are today very potent factors in determining the direction of ocean trade routes.

318. The North Atlantic Trade Route. From the preceding section some idea will have been gained of the importance of the use of the globe in studying the ocean trade routes. One should also be in a position to understand that great circle sailing has the effect of concentrating the traffic across the North

Atlantic Ocean along a main trunk route. It will be evident from the work done in studying great circle sailing that the North Atlantic route is a great trunk route focussing on the English Channel at the European end, and spreading out into a string of branches at the American end for the different ports, from St. John, Newfoundland, to Havana, Tampico, and Vera Cruz in the Gulf of Mexico.

In accordance with these great fundamental facts there is springing up a great trans-shipment trade between the West Indies and the Caribbean countries and such ports as New Orleans and New York, by which the products of these lands are fed to the main stream of traffic through the activities of a host of small steamers. That is to say, the greater and faster ocean steamships ply regularly to and fro along the main track from the European ports to the great ports on the American side, like Montreal, New York and New Orleans, and pick up at these ports the cargoes collected by the smaller or subsidiary shipping lines, leaving at the same time valuable cargoes of manufactured goods for distribution along the route of the coastwise steamer.

It is at this point advisable to check up our ideas of distance between ports at either end of this route.

To those who do not use a globe and who do not realize fully the shape of the earth, it is rather astonishing to find that North American points which are far inland may be nearer a European port than those which are situated on the seaboard of the continent. Take, for example, the great river port of Montreal. Glancing at a flat map of the world, one's first impression is that New York or Boston must be nearer Liverpool than is Montreal. This, however, is not so. Montreal is 2,760 miles from Liverpool, while New York is 3,707, a difference of almost 950 miles in favor of Montreal. This is caused by the narrowing longitude as we go from lower to higher latitudes.

Owing to the working out of this fact, there are places located nearly in the centre of the continent, such as, say, Fort Churchill, which are nearer to Liverpool than is New York. These are facts to be carefully considered in respect to the Hudson Bay route.

The North Atlantic route is far and away the most important of the great ocean trade routes. There are several contributary reasons for it being so, the principal of which are:

(1) It connects the centres of activity of the two most highly industrialized continents.

(2) Each end of the route has in great abundance the things the other has not. For example, Europe has a surplus population which in order to live must seek room elsewhere, whilst the North American continent has abundance of space and wants workers to develop its vast stores of natural wealth. On the other hand, Europe is a great purchaser of raw materials, and these the North American continent produces in great abundance.

This route is, consequently, the greatest immigration route and the greatest freight route in the world. One-sixth of all the ocean-borne shipping is said to pass over this route. Its shipping facilities are noted the world over as being the very finest product of the designer, the builder, and the marine engineer. On this route are the wonder vessels of the world, veritable floating palaces. Consider, for instance, the *Majestic,* that great German vessel which, by the terms of the Treaty of Versailles, was handed over to Great Britain in order to make reparation for the submarine campaign carried on by the Germans. She is of the following dimensions:

Length, 956 feet.
Breadth, 100 feet.
Depth (keel to boat deck), 102 feet.
Gross tonnage, 56,550 tons.
Passenger capacity, 4,000.
Crew, 1,000.

This is only one (the largest, it is true) of the many fine vessels which regularly ply over this route.

The North Atlantic route has the great advantage of being free in its middle stretches of any dangers to navigation in the form of islands, sunken reefs, etc.

At each end, however, there are very dangerous approaches. Its two most dangerous points on the west are:

(1) Sable Island, east of the coast of Maine, and a few small rocks on the Grand Banks.
(2) Cape Hatteras, which was discussed in the last section.

Sable Island is so universally dreaded by captains using this route that they refer to it as the "graveyard" of the Atlantic and always aim to have a clear 60 miles of water between them and the island.

Another factor which makes this zone around Sable Island and the Grand Banks a danger zone is the almost continuous presence of fogs. These fogs are caused by the mingling of the cold waters of the Labrador Current with the warm waters of the Gulf Stream. Around this zone also, especially in summer, are found great icebergs. These are loosed by the warm summer weather from the great ice-sheets of the Arctic and drift with the Labrador current right across the shortest path of the shipping. The icebergs are an even greater menace than the islands, since their position is continually changing.

In order to render this route as safe as is humanly possible, most elaborate precautions are taken, and the movements of the ships are controlled and directed by powerful wireless stations. The coastal waters at either end of the route are most elaborately buoyed and lighted.

The North Atlantic traffic is, more than any other, a traffic of a dual nature.

The westbound shipping movement is largely one of passengers and ships in ballast, whilst the eastbound traffic consists largely of freight.

Europe supplies mostly passengers and relatively small quantities of high class freights, whilst America supplies raw material, cotton, wheat, corn, meat, lumber, copper, and cattle foods.

In order to carry something which will give weight and so steady the ship on its journey, ships take on board cargoes of very cheap material. Now, it is obviously better for a ship to carry something which, even if it will not fully pay for the trip, will contribute something towards the expenses, than for her to carry worthless ballast like sand and stone. Consequently the west-bound ships bring over such bulky and cheap commodities as coal, iron ore, iron, chalk, china clay, etc., as ballast substitutes. Coal, carried as a ballast substitute in grain vessels, from Wales to Montreal, competes with our Alberta coal in the markets of Eastern Canada.

Fuel Supply. This route is splendidly served as regards fuel supply. No other trade route can equal it in this respect. Even with the modern trend towards oil-burning ships, this route is better placed than any other for securing an edequate supply of fuel.

At the present time the coal outputs of Northern Europe and Eastern America amount, combined, to more than 90% of the world's coal output, and the supply is splendidly distributed along the seaboard at each end of the route.

Eastern Canadian ports use Nova Scotia coal.

Middle Atlantic States use Pennsylvania coal.

Chesapeake Bay ports use Maryland and Virginia coal.

New Orleans and Gulf ports use Pennsylvania coal which has been carried down the Mississippi River in barges.

At the European End—

Liverpool and Bristol use Lancashire and Welsh coal.

Glasgow uses the Western Scottish coalfields product.

Antwerp and Rotterdam use Westphalian coal brought down the Rhine in barges.

Hamburg and Bremen use Newcastle coal carried as return cargoes in the sugar ships.

Oil fuel is supplied from Texas, Oklahoma and Tampico.

In studying a trade route, it is advisable to link the names of the ports with some characteristic exports. This assists not only in remembering the mere names but assists also in visualizing the types of cargoes one may expect to find in the vessels frequenting them. As examples:

Montreal sends to Europe wheat and meat.

Quebec—Lumber.

Halifax—Apples, pulp and paper, fish.

St. Johns, Newfoundland—Fish and paper.

New York—Grain, and animal products.
New Orleans—Cotton.
Savannah—Cotton.
Baltimore—Tobacco.
Liverpool—Cotton and wool textiles, manufactured steel goods, crockery.
Glasgow—Machinery and linen textiles.
Hamburg—Potash, salts, and dyes.
Rotterdam—Bulbs, and chemicals from Germany.
Antwerp—Glass and carpets.
Havre (port for Paris)—Imports raw cotton from America and exports wines and fancy goods.
Copenhagen—Butter and other dairy products.
Stockholm—Paper, pulp, lumber, and matches.

Other similar facts can be collected for other ports.

One of the important requirements along any trade route is facility for repair. This necessitates the provision of dry-docking facilities. This route is very well supplied in this regard. In Canada the principal dry-docks are at Halifax and Levis.

All the great European ports have ample provision in this regard. In time of war it is necessary to provide adequate protection for shipping. This is especially so with regard to the British Empire, for the British Isles depend almost entirely on the ocean traffic for their food. This was clearly brought out during the late war.

The British have carefully looked after this side, since in stress of war the quickest route is the easiest defended, and besides its utilization releases more vessels for the transportation of war materials and men.

Halifax is a strongly fortified port with a magnificent harbor and complete repair facilities available.

The principal link in the defence of our shipping in the North Atlantic is, however, the naval station of Bermuda, which has a position well removed from possibility of attack by the air. It has also a central position in the great western embayment of North America and is well situated to protect the ocean routes connecting Canada with Great Britain. The position of Bermuda and its importance as an operating base for the British navy should be studied by means of a globe and pieces of string as explained in the last lesson.

Then, again, no foreign ports flank the route between Canada and the west coast of Great Britain.

Communications. Rapid communication is a great help in modern commerce. No other trade route is so well equipped in this regard as the North Atlantic route. Communication is obtained by:

(1) Fast steamship lines.
(2) Submarine cables.
(3) Wireless stations.

Important British submarine cable stations on this route are:

Valentia Island, Dingle Bay, Ireland.
Trinity Bay, Newfoundland.
Placentia Bay, Newfoundland.
Sydney, Cape Breton Island.
Bermuda.

Important British wireless stations on this route are as follows:

Valentia Bay, Ireland.
Poldhu, Cornwall, England.
St. Johns, Newfoundland.

There are, of course, many other important stations for cable and wireless communication operated by other than British control. The most notable are those controlled by the United States.

319. The Mediterranean-Black Sea Route. This is an important trade route in normal times, but its value of recent years has been sadly impaired by the collapse of the Russian Empire. It is a route which at the present time is serving a "hinterland," the development of which is yet to come. The most important place on the route is Constantinople. This is so, not because it is the city having the largest volume of trade, for in normal times both Odessa and Batoum exceed Constantinople in this respect. It owes its importance to its wonderful strategic position on the only water passage from the Mediterranean to the Black Sea. This passage begins with the Dardanelles, a strait some 50 miles long and averaging three or four miles in width. From thence we pass into the Sea of Marmora, a spacious body of water about 50 miles wide and about one hundred and seventy miles in length. Next we pass into the Bosphorus, a strait 20 miles long and much narrower than the Dardanelles. At the beginning of the Bosphorus stands the city of Constantinople. Its site as a strategic point is unrivalled by any other position in the world.

The two straits resemble a great river in that they have a considerable current. Their waters are, however, clear and deep and throughout their whole length there is neither dangerous headland nor bar nor shallow place to hinder their free navigation.

The magnificent strength of Constantinople as a military position was shown in no uncertain manner during the Great War, when the most powerful navy of the world failed utterly to force the straits. The city's importance has been realized for more than three thousand years. Constantine the Great recognized it when he transferred his headquarters to the ancient city of Byzantium and re-named it "Constantinople." Centuries later, when Napoleon and Czar Alexander I. of Russia

met at Tilsit to arrange the treaty which divided the world between them, Alexander is said to have pleaded with Napoleon to give Russia Constantinople. "For Constantinople, Russia will make any sacrifice," said the Czar. It is said that Napoleon bent long over the map, and then straightened up, replying with sudden resolution: "Constantinople? Never. That means the rule of the world."

Today the same opinion holds. In more recent years it caused Britain to range herself alongside France and Turkey against Russia to fight the Crimean War, the real reason for which was to prevent Russia from gaining control of this passage.

Germany made a bold bid in the final decade of the last century and up to the outbreak of the Great War to control this position, and nearly succeeded. The determination to prevent Germany's domination here must be considered as the chief issue which caused Russia under the rule of the Czar to join with France and Britain.

After the war we saw the spectacle of Turkey being allowed to resume control of the passage once more, because France could not trust the British influence with the Turk.

These are not the only wars which have been waged over the ownership of this passage, and unfortunately there is no guarantee that there will not be others.

Merchant and strategist alike still rank Constantinople as the most valuable of territorial possessions, and not one of the great powers of the world will stand idly by whilst another obtains possession.

This is the reason for the continuance of a weak nation like Turkey as guardian of the passage.

The sober opinion of the world is that Constantinople stands unapproachably first among the great gateways of commerce and the strongholds of war. Some reasons for this are as follows:

(1) It is the only great highway for which there is no alternative.
(2) It gives access to a greater hinterland than does any other single entrance in the world.
(3) It is the most impregnable of all entrances.

Consider each of these points in turn.

The only alternative means of access to the Black Sea from the Mediterranean would be by means of railways paralleling the straits on either the European or Asiatic mainland. Look at the map of the region and see how difficult this would be, owing to the mountainous mass of the Balkans on the northern side and the equally mountainous area of Asia Minor on the southern side.

The railroad construction necessary to give access to the Black Sea region would be so costly as to be prohibitive, and, furthermore, the congestion would be so great as to render futile any competition with the Constantinople water route.

Let us now consider the next point, the hinterland or country tributary to the passage. Study the map again. First we see the south-eastern portion of the Balkan Peninsula still left to Turkey. Then above that Bulgaria, all of whose rivers, valleys, and railroads lead and must always lead to the Black Sea. At Constantinople terminates the great international railway route from Paris, via Strasburg, Stuttgart, Munich, Vienna, Budapest, Belgrade, Sofia, and known as the Orient Express Route. This is a line, the terminus of which cannot be easily changed, since the topography of the land inexorably forces it along its present course.

Then, again, consider the Danube, a navigable waterway of the highest importance. The value of this river is so great that it has, since the Balkan wars of the second decade of the present century, been administered by an International Commission.

The Danube brings the great area of the fertile plains of Austria and Hungary and even the tableland of Czecho-Slovakia within the hinterland of the region. The volume of traffic over the Danube is far greater than the average student supposes. It all passes into the Mediterranean by way of the Black Sea, the Bosphorus, and the Dardanelles. Rumania, with its great wheatfields and oilfields, and more than half European Russia are dependent on the Black Sea as an outlet for their products.

Russia depends a great deal on its great river systems, the Dneister, Dneiper, Don, and Volga, all vast river systems navigable in both main stream and tributary, and all of them, save the Volga, emptying into the Black Sea.

The Volga, the greatest river in Europe, flows into the Caspian Sea, but its traffic is diverted by rail to two points on the Black Sea. Look at the map again and you will see that at Tsaritsyn the Volga and the Don almost join. Here a line conveys the freight to the Don down which it is carried to the Sea of Azov. This Sea of Azov is very shallow and unsuitable for ocean steamers to navigate, so a new line runs from Tsaritsyn to the magnificent new port of Novorossiysk at the north-east end of the Black Sea. Furthermore, the Caspian Sea has no outlet, and the products which are collected from a huge region down the Ural River and from the Steppes of the Khirghiz, are also sent to Novorossiysk or Batoum by railway. Here, also, on the shores of the Caspian, are the great Baku oilfields, which are connected with Batoum by a pipe line.

To the south of the Caspian Sea lies the great and wealthy country of Persia. Most of Persia is tributary to the Black Sea via the ports of Trebizond and Sinope. It is true that Persia has another outlet via the Persian Gulf, but the Suez Canal dues will always tend to swing the Commerce of Persia through Batoum or Trebizond.

This region is in a backward state of development, and since the collapse of the Imperial Government in Russia its commerce has fallen off, but it must come back, and when it does there will be great developments here..

The actual commerce of the Dardanelles is much greater than is usually supposed. Twelve thousand ships a year pass the Dardanelles. That such a stream of commerce has been maintained under the most adverse political conditions is indicative of what this route is destined to become with the return of stable governments in the vast area which it serves.

The principal ports on this route are:

Constantinople—

Exports: Persian carpets, silk, wool, mohair, currants, raisins, figs, opium, and olive oil.

Imports: Textiles, sugar, rice, flour, hides, iron, ware, petroleum, and coal.

Varna, principal Black Sea port of Bulgaria—

Exports: Wheat, corn, animal products, animals, cocoons.

Imports: Machinery and metal goods, textiles, sugar, coffee, and timber.

Galatz, principal port of Rumania and the Danubian region—

Exports: Grain (78%), wood, and animal products.

Imports: Textiles, and metal ware.

Odessa, most important port on the Black Sea—

Exports: Grain and timber.

Imports: Machinery and metal goods, textiles, raw cotton, wool and silk.

Novorossiysk—

Exports: Petroleum, wheat, furs, fish, products, raw cotton, raw silk, and Bokhara rugs.

Imports: Same as Odessa.

Batoum—

Similar exports and imports to Novorossiysk.

Trebizond, at the Persian end of caravan route from Tabriz to Black Sea—

Exports: Opium, tobacco, raw silk, manufactured silk, cotton, wheat, grapes and dates, hand-woven carpets and shawls, attar of roses.

Imports: Iron ware, cheap cotton, textiles, machinery.

320. The Mediterranean-Asiatic Route. It would be difficult, indeed, to overstate the value of this route to the British Empire. Although it does not carry so large a tonnage as the North Atlantic route, it nevertheless is the only other ocean trade route to rival the North Atlantic route in this respect.

Its great importance to the British Empire, however, is due to something besides mere tonnage and freight. This something is termed its "strategic importance."

The route passes through the "Heart of the World." It serves 370 millions of people in Europe, 70 millions in Atlantic North America, and 800 millions in Asia. If the African quota

is added the total number of people served by this route would be over 1,200 millions, or more than three-quarters of the world's population. In fact the only really large masses of population not served by this route are the savage tribes of Central Africa and about 40 millions of South Americans.

No other trade route, either ocean or land, can even approach the Mediterranean-Asiatic route in this particular.

The route owes its importance to the genius of De Lesseps, who, in 1869, cut the Suez Canal across the isthmus of that name. The importance of canal communication between the Mediterranean Sea and the Indian Ocean has been recognized since the dawn of civilization. History tells us that twice before has this water connection been made by man.

Why is this canal so important today? There are two principal reasons:

(1) It is the gateway between the railway termini of West Europe, the greatest manufacturing centre of the world, and those of the monsoon lands of Asia, the greatest centre of population.

(2) It is the shortest route between the railways of East North America and India. (North America has the only other great manufacturing population of the world, outside of Western Europe.)

Another point not sufficiently realized by people living on the North American continent is that the distance between the great naval bases and shipbuilding yards of the United States and Manilla in the Philippines is exactly the same by Suez as by Panama, but owing to the great distance between stations via Panama the latter route would be of less value to the United States than the Mediterranean route in protecting her distant possessions, the Philippines.

So much for the strategical importance of the Mediterranean-Asiatic route. Commercially it is even more important, because, owing to the topography of the land masses it serves, it can never be seriously threatened commercially by building land communications.

Take the case of a few of the lands along the route, e.g.:

Europe. The mountain masses of the Alps and Balkans make transportation of freights expensive.

Asia. India must always be served by this route since the great mountain masses of the Himalayas and the Pamirs prevent easy communication by land. China is also shut out from cheap land communication in a similar manner, but even more so because of the Gobi Desert. All transportation between India and China must inevitably be borne on this route. It will thus be seen that this route may almost be considered as the "Main Street of the World." An American writer recently said of it: "It is the world's oldest and well nigh its greatest highway; a

highway which has at once the shortest through route and the richest local traffic; and a highway withal which can be easily dominated from a few strategic points."

The control of this important highway is dominantly British. Take your map of the world and look for the strategic points, you will see they are all held by the British, and that the control exerted is essentially naval. Notice that the Western and the Eastern entrances to the Mediterranean are both held by the British, viz., the Straits of Gibraltar and the Suez Canal.

Consider the Western portal first: This is a narrow strait about 8 to 10 miles in width, with steep shores on each side. On the north shore the height consists of a huge isolated mass of rock, which although connected to the mainland by a narrow sandy strip is almost an island. This is Gibraltar, in popular opinion the most famous and impregnable of all fortresses.

Now whether it be as impregnable as popular opinion pictures it matters little. What is really certain is that most people misunderstand both its nature and its purpose.

In popular opinion it is commonly assumed that its function in war would be to prevent a hostile fleet from passing the straits. This, however, is only incidental, and to make sure of being able to do this, Great Britain would have to seize and fortify the heights on the African side.

No, the function of Gibraltar is not to do this; that is the work of the navy. It is very problematical if Gibraltar alone could stop a fleet of the modern type. What, then, is the use of Gibraltar to Great Britain?

The answer becomes obvious if we consider the nature of naval warfare. The warship, heavy and very powerfully engined, has not a very large range because she must consume such a large amount of coal or other fuel in order to drive her great weight quickly through the water. The warship under war conditions can only operate from a base to which she can quickly return for fresh supplies of ammunition and fuel, and where she is able to secure repairs to hull and machinery. And she must also be within easy reach of some garrison post whence she can draw men to fill the gaps in the fighting force.

The condition of a navy's successful operation in distant waters is, therefore, the possession of suitably located naval bases. This is Gibraltar's function. The actual work of stopping the hostile fleet would take the form of a naval operation somewhere to the west of the straits, and Gibraltar would be the base from which the fleet would operate.

The sea power of England consists not only in her ships, but quite as much in the long line of naval stations which she possesses in all seas, but nowhere so well and strategically placed as upon this great highway.

The next position occupied by the British in the Mediterranean is that of Malta. Look up its position ar[illegible]e how well

placed this island is for the purpose of a naval base. If a hostile fleet should force Gibraltar, it would still have to reckon with the fleet operating from there. Malta is the second line of defence of the Suez Canal.

The defence of this canal is even more vital to Britain than the defence of Gibraltar; yet, owing to international agreement, the canal itself is not fortified, and is under pledge of neutrality in war.

How, then, does Britain, which owns the majority of shares in the canal, defend it?

The real defences of the canal are Malta in the centre of the Mediterranean, 1,100 miles to the west of it, and Aden on the Red Sea, 1,300 miles to the south of it.

Here, again, reliance is placed on the fleet and not on the forts, the work of the forts being to protect the bases and not really bar the passage either way.

Gibraltar, Malta, and Aden, then, are naval bases of first class importance.

Consider carefully their position. Notice how the Canal zone is protected on the right and left hand by the deserts, and between the desert and France on the one hand are the countries of Egypt and Tripoli, both friendly to Great Britain, and neither of them possessing first class navies.

On the other hand, after the desert comes Palestine, where Great Britain is responsible for the government; and on the long Asiatic shore of the Red Sea, between Aden and Port Said, are the kingdoms of Irak and Hedjaz. Both these new countries owe their status of independence to Great Britain.

Egypt was granted independence in 1922, but Great Britain retains suzerain rights; that is, Egypt cannot make foreign alliances or agreements without the consent of Great Britain. Now, of course, other strong naval nations bordering the Mediterranean have naval bases, but they entered the race late, and had to take second place. Their bases are, therefore, not nearly so well placed as those of Great Britain.

The route is well supplied with coaling stations, but the distribution of the coal fields is not the most favorable, because the fields are at the ends of the route, viz., in Great Britain and Eastern North America at one end, and in Japan and Australia at the other end.

The middle section is devoid of coal fields. But so far as Great Britain is concerned this is a help rather than a hindrance, for she is the only European power with large quantities of coal for sale. France and Germany both purchase immense quantities of coal from her. This enables Great Britain to send out her vessels laden with coal cargoes which are exchanged abroad for the necessary raw materials for her large manufacturing industries. It also gives her a further control over the region.

Let us glance at the fueling conditions. All coaling stations from Gibraltar to Colombo use Welsh coal. From Colombo to

Singapore, the Australian and South African coal is gradually replacing the Welsh. From Singapore eastward, Japanese and Australian coal is used.

With the advent of oil-fuelled steamers this route will find itself well placed; with American oil at its western extremity, Rumanian and Russian oil at Port Said, Persian oil for Aden and Colombo, and Dutch East Indian oil for Singapore and the East.

It was the struggle for the centrally placed Irak oilfield which caused the trouble about Mosul. Great Britain, France, and America all want it. Great Britain controls this oilfield at present through her mandate over Irak. Can she retain it? If she can, this will mean a strengthening of her already splendid position on this highway.

Chief Ports of This Route—

London is the chief English port for trade with other ports on the route. Machinery and manufactured cotton textiles form its principal exports.

Bremen and Hamburg are the greatest German ports. The exports are the same.

Amsterdam is a great Dutch port.

Antwerp is one of the finest ports in the world. It ships the products of Belgium and part of the products of the Rhine valley, machinery and cotton textiles being of greatest importance.

Oslo (formerly Christiania) in Norway, and Stockholm in Sweden, send large quantities of timber and other forest products over this route.

Bordeaux, the world's greatest wine-shipping port, and Marseilles, on the Mediterranean, are France's greatest ports on the route. Marseilles is the greatest soap and oil port in the world. It is also the port of entry for raw silk from Italy, China, and Japan for the great silk industry of Lyons.

Barcelona, the principal Spanish port, often called the Manchester of Spain, ships out cotton goods, olives and olive oil. The "Queen olives" are all grown round this city.

Genoa, Italy's greatest port, exports manufactured silks, macaroni, and jewelry.

Trieste, at the head of the Adriatic Sea, was formerly Austria's chief seaport. It now belongs to Italy. It is the chief outlet for Central Europe.

Brindisi, near the heel of Italy, is the terminus of the railway train known as the "Overland Express." It is an important mail and passenger trans-shipping point.

Alexandria, the port of Egypt, ships principally raw cotton to Great Britain, about 80% of its exports being cotton. Wheat also bulks large among the remaining 20%. Sugar is also exported.

Port Said, at the Mediterranean entrance to the Suez Canal, is an important coaling station.

Suez is at the Red Sea end of the canal.

Karachi, at the mouth of the Indus River, is a great wheat-shipping port of India.

Bombay is the chief railroad centre of the Indian Empire. It exports raw cottons and oil seed.

Colombo, principal port and city of Ceylon. Important tea and rubber port. Great coaling station.

Hong Kong is an important entrepot for the trade of Southern China. It is an island near the mouth of the Canton River. One of the most important British possessions in the Pacific. Exports raw silk and tea.

Shanghai is the principal port of Northern China. Exports raw silk and tea.

Wei-Hei-Wei is an important British trading centre for Northern China.

Yokohama is the principal Japanese port. Exports raw silk, tea and coal. An important exchange of products between Japan and India is carried on from this port. Considerable trade is also carried on between Japan and Java and the Philippines from this port. India exports rice while Japan in return sends coal and some manufactured goods. Java and the Philippines send sugar to Japan in exchange for coal.

Sumatra is an island belonging to Holland. Tobacco is the principal export and Padang the principal port. Petroleum is also exported in large quantities.

Java, an island belonging to Holland, has a population of about one-third that of the United States, and is about the size of the State of New York. Sugar is its principal export. It produces one-fifth of the world's sugar, only Cuba and India producing more. The sugar mostly goes to the United States, China, Japan, India and Australia; practically none of it goes to Holland. Coffee, also, is important, Java coffee being famous the world over. Cocoa, rubber, ebony, and camphor are important exports. Cinchona bark, from which we obtain quinine, is now obtained almost wholly from Java. Batavia, Samarang, and Surabaya are the ports.

Banka and Billiton are islands belonging to Holland. They export tin.

Australasia is also tributary to this route, but its ports and products will be considered under the Cape of Good Hope route.

321. The North Pacific Route. In considering this route there are certain very important geographical factors to notice. These are:

(1) The great size of the Pacific Ocean.

(2) The relative positions of the coasts of Asia and North America.

(3) The importance of the great circle factor.

(4) The presence of fuel.

(5) The volume of trade.

(6) The location of the great manufacturing centres of the world.

In no other ocean does the distortion of the ordinary Mercator map produce such absurdities. For instance, consider the coasts of North America and Asia. On the Mercator map these seem to be opposite to each other, whereas an inspection of the globe will show that they are really in a direct line with one another. They form part of a "Great Circle"; and there is no short cut across the ocean as is wrongly suggested by the map. Again, the Hawaiian Islands appear to be in the geographic centre of the ocean routes on a Mercator map. This is not so. The most direct route from the Panama Canal to Manilla in the Philippine Islands curves far to the north of the Hawaiian Islands. As a matter of fact, as already pointed out, a ship, to follow it absolutely would have to pass through the Caribbean Sea, the Gulf of Mexico, and then overland through Texas, Vancouver Island, Alaska, and Japan. This being impossible, a vessel bound for Manilla via Panama pursues a middle course, the object being to attain a best route between the true great-circle line and the long detour which would be caused by trying to pass directly across the Pacific Ocean in the vicinity of the Hawaiian Islands. To accomplish this she skirts the Pacific coast to North America until the latitude of Southern Canada is reached. The course is then changed and the Pacific crossed. This brings the ship in Yokohama. Such is the shortest practicable line across the Pacific between any two ports in Asia and North America in the Northern Hemisphere. Practically every vessel crossing the North Pacific stops at Yokohama. Hence this is the port which dominates the North Pacific Ocean.

This domination is all the more complete since here are the only producing coalfields on the Asiatic side of the route. But the journey between ports is long. Vessels arriving at the American side must coal. The only ports which have coalfields in their vicinity are the Canadian ports of Prince Rupert, Victoria, and Vancouver. These Canadian coalfields are thus of immense strategic importance in the fixing of trade routes across the North Pacific. South of the Canadian coalfields there are no other known fields until the Chilean coalfields, south of Valparaiso, are reached. At the present time the San Francisco steamship lines prefer to take the longer and more southerly route so as to call at the Hawaiian Islands, although this causes a detour of about 700 miles. They are constrained to do this because of the mail, passengers, and cargo which can be picked

up on these islands or at Guam. Vessels bound to Japan, China, Hong Kong, or Manila from Vancouver or the United States Puget Sound ports never put into Hawaii.

At present this route is not a great carrier of freight, but the increasing demand of the East for wheat and meat, as well as for North American manufactured goods, will undoubtedly cause a marked difference in conditions. Silk is the principal commodity now carried from east to west over the route. The high price of this article allows it to stand the high cost of rail transport from the Pacific seaboard to the eastern cities of North America.

322. The Cape of Good Hope Route. This is the oldest of the purely oceanic trade routes. We owe its discovery to the vision and energy of a Portuguese Prince, known in history as Prince Henry the Navigator. Prince Henry was a brother of the King of Portugal and a cousin of King Henry V of England. He had become possessed of a copy of that wonderful book, *The Travels of Marco Polo,* the Venetian, who, with his two uncles, had travelled across the whole width of Asia to the court of Kublai Khan, the Mongol ruler of the vast empire which stretched from the Pacific Ocean in the east to the mouth of the River Don in Russia on the west.

This remarkable book is one of the great books of the world. To it and its stories of the great wonders of Cathay (Northern China) and the City of Cambulac (Pekin) we owe the great voyages of the fifteenth century, which resulted in the discoveries of America and the Cape of Good Hope, and in Magellan's glorious first voyage round the world.

Prince Henry of Portugal, studying his copy of this book, settled himself in a palace or castle on Cape St. Vincent. Here in sight of the great Atlantic he gathered together travellers and seamen from all parts. He stimulated the nobles of Portugal to study seamanship and founded there a school of navigation which was to raise Portugal to the dizziest heights. His great desire was that the Portuguese might discover a road to the Indies around Africa, and win fame and wealth from the trade in spices, which were brought to Europe at this period through Aleppo or Alexandria and afterwards sold in the market at Venice, which was then the commercial entrepot of the world.

Year by year, from his school of geography and navigation at St. Vincent, he sent out ships to explore the coast that no one had visited from the Mediterranean, since the days of the Phoenicians. His first success was the discovery of the island of Madeira. Prince Henry died in 1460, but by this time his captains had reached the Gulf of Guinea and were trading along the coast. He was 65 years of age when he died, and had laid the foundation of Portugal's commercial supremacy. He had taught his captains to take no note of the legendary monsters and whirlpools of the seas, but to trust in their ships, their compasses, and their astrolabes.

After Henry's death, King John continued his work and in 1471 Fernando Po discovered the island which has ever since borne his name, and found that the continent bent southward. This was a great disappointment, but the hardy navigators of Prince Henry's school stuck doggedly to their task, and slowly the map was unfolded. In 1475 they crossed the Equator. In 1486 King John sent out Bartholomew Diez who, after struggling hard against wind and current, passed all his predecessor's land marks and reached Angra Pequena. Here he landed and raised a stone cross. This cross, it is interesting to note, remained in position until 1856, when it was removed to the Cape Town museum. He pushed farther south and five days later was caught in a storm and driven before it for thirteen days far out of sight of land. He steered east, hoping to strike the African coast, but, after many days' sail, no land appearing, he turned northward again, and presently sighted land. Here he landed in a bay where many cattle were feeding under the care of a herdsman. This was Algoa Bay, where is found now one of the principal ports of South Africa, known as Port Elizabeth.

He sailed farther east for about 60 miles to the mouth of the Great Fish River, but his men and officers refused to go farther and he reluctantly turned back. On his way home he passed the Great Cape of South Africa, which he called the Cape of Storms. On reaching Portugal, King Emmanuel changed the name to Cape of Good Hope, since he said their hopes of finding the sea route to India were about to be realized.

In 1497 Vasco da Gama was given command of three small vessels and a store ship and bidden to complete what Prince Henry had begun. He was successful and reached Calicut on the west coast of India in May, 1498. After a stay of nearly six months, the Rajah of Calicut gave Da Gama letters to the King of Portugal and allowed him to depart. He reached Lisbon in 1499.

The success of Vasco da Gama's voyage meant ruin to the trade of the Mediterranean with the East. The Venetians considered it the worst news that had ever arrived in their city.

The Sultan of Egypt was as terrified as the Venetians, for his revenue came from duties levied on goods passing through his dominions from Suez to Alexandria.

In 1500 Pedro Alvares Cabral founded the first Portuguese factories in India, one at Calicut and the other at Cochin. The factory at Calicut was destroyed and its merchants massacred soon after Cabral left. Vasco da Gama returned to India in 1502 with a fleet of twenty vessels and many soldiers. His first care was to make alliances with the Rajahs of Cochin and Kannanor and also with the Ranee of Quilon. He then bombarded the Rajah of Calicut's palace as a punishment for the massacre of the Portuguese merchants and the destruction of the factory. In 1503, Da Gama returned to Portugal. Within a few years of

Da Gama's bombardment of Calicut, the Portuguese Viceroy D'Albuquerque had seized Ormuz at the entrance of the Persian Gulf and put an end to the trade through the Red Sea.

The Venetian galleys returned empty from Alexandria, whilst the Portuguese vessels returned to Lisbon laden with spice and silks. Venice never recovered from the blow, and Genoa fell with her. The title of "Mistress of the Seas" now passed to Portugal. In India and the Far East she established markets at Goa, Colombo, and Malacca, and for a time the Portuguese were absolute lords of the Eastern seas.

Today there remains to them four or five sleeply old-world towns with tiny settlements around them, to remind us of the glorious days of Portugal in the East, before Dutch, French and British sailors disputed the authority of Portuguese viceroys. Such is the story of the discovery of the route. It is one of the most romantic stories in history.

Before the cutting of the Suez Canal, the Cape route was the most important one in the world, but after the canal was cut, the Mediterranean recovered most of its old-time importance as a trade route to the East.

It must not, however, be thought that the Cape route is now of little value. It is still very important; and although Calcutta is more than 2,500 miles farther from Montreal or New York by the Cape than it is via the Suez Canal, many vessels prefer it. Observe its double terminals at one end, London and New York; and triple terminals at the other, viz., South Africa, East Indies, and Australia. Transportation to Australia by it is cheaper than via Suez, owing to the canal tolls.

Exports of South Africa—Angora hair, wool, hides, skins, ostrich feathers, gold, and diamonds.

Exports of Australia—Wheat, flour, meat, wool, farm products, gold, copper, and pearls.

Exports of East Indies—Tea, coffee, tobacco, cocoa, pepper, cloves, nutmegs and other spices, and tin.

Vessels bringing cargoes to Cape ports, owing to the nature of the freights available at these ports, are compelled to seek freights elsewhere. Cape Town thus becomes a great scattering point for chartered steamers. Some go to South America, some to Bombay for grain and cotton, some to Rangoon for rice and teak, some to Java for sugar and spices, and others go to Calcutta for jute.

Principal Ports of the Route—

London, Southampton, Liverpool, in Great Britain. Montreal and New York in North America.

Funchal on the island of Madeira and Las Palmas or Teneriffe on the Canary Islands are important coaling points.

Cape Town, chief South African port and one of the world's most important coaling stations.

Port Elizabeth—Important wool and feather port.

Durban—One of the most important ports on the route. Has good coal. Ships come here to receive this coal and convey it to Bombay for use on the Indian railways.

Albany—Important mail and passenger-connecting port in Western Australia, also ships jarra pine for African railroad ties.

Melbourne—Very important Australian port. Wool, grain, meat are the exports.

Sydney—The finest Australian port. Exporting principally wool, grain and meat.

Newcastle—Important coal-shipping port, sends Australian coal to Singapore for use on the Mediterranean-Asiatic route.

Brisbane and Rockhampton are important ports in Queensland. They ship beef and sugar. Beche-de-mer and trepang are also concentrated here and shipped to Singapore to be sent to China.

Auckland, Wellington, Christchurch and Dunedin are the principal New Zealand ports. They chiefly export beef and mutton carcases, phormium or New Zealand flax, and Kauri gum.

The fuel supplies on this route are not very satisfactory. As far as Cape Town or Port Elizabeth, Welsh coal is used. Natal coal is available for the middle section and is very good. In the event of oil becoming the dominant marine fuel, this route will be badly off, there being no potential oilfield in sight in either South Africa or Australia.

323. Panama Canal. The canal is 43.8 miles long, has three locks on the Atlantic side and two on the Pacific. It is 41 feet deep, built to take the largest vessel yet afloat. Its highest level surface is 87 feet above the sea. Its Atlantic port is Colon and its Pacific port is Panama.

The Panama Canal zone is a strip of land extending five miles on either side of the canal, excluding Panama and Colon. It covers an area of 441 square miles. It was granted to the United States by the treaty with Panama, February 26, 1904, by which the United States paid $10,000,000 and also makes an annual payment of $250,000 to the Republic of Panama.

The Panama Canal cost the United States Government about $275,000,000 to construct.

The effect of the Panama Canal upon the ocean trade routes of the world is as follows:

(1) It reduces the distance between Canadian and United States Atlantic and Pacific ports 8,415 miles.

(2) It brings Liverpool and English ports 6,000 miles nearer to all parts on the western seaboard of America, north of Panama. This accounts for the great attention which is being given the shipping of grain, lumber and salmon from Canada via the Panama Canal instead of by the St. Lawrence.

(3) Nearly the whole of the Atlantic seaboard in the Old World and the New is brought nearer to Pacific ports of the United States and Canada.

(4) The saving of time between New York and the Pacific ports of America south of the Panama depends on how far south these ports are. It is about 8,000 miles from New York to Cape Horn by Panama and 8,500 miles by the Atlantic.

(5) Liverpool and Pacific ports of South America are brought much closer by water than they were before and in consequence we find that nitrate of soda is the most important material from the standpoint of tonnage that passes through the canal.

(6) The canal does not bring any port in Australia or the East Indies, or any ice-free port in Asia or Asiatic Islands nearer to any European ports. Only the New Zealand ports and a few of the northern Siberian ports are brought nearer to Liverpool.

(7) All of Asia and all of Australasia except New Zealand are nearer Europe by Suez than by Panama.

(8) Nearly all of Japan, China, Philippines, all Australia save a far western strip, and all of New Zealand are brought nearer to Atlantic and Gulf ports of Canada and the United States.

(9) Relative distances from New York and Liverpool to Asiatic ports south of Hong Kong remain unchanged.

(10) New York is now nearer than Liverpool to Yokohama, Sydney, and Melbourne.

(11) The Panama Canal cannot invade the main traffic field of the Suez Canal or the countries of South-Eastern Asia, East Africa, the Red Sea, and the Persian Gulf. The region of competition lies east of Singapore in the western Pacific Ocean.

324. South American Trade Route. This route extends from the English Channel to Punta Arenas. Principal places en route: Madeira, Canary Islands (Las Palmas, St. Luiz de Teneriffe), and Cape Verde Islands. The principal country on this route is the Argentine Republic (population 8,000,000). The principal city is Buenos Aires (population 1,800,000), the largest city south of the Equator. The area of Argentina is one-third the area of Canada. Within its boundaries one finds every variety of climate, from the tropical heat of the north to the bitter cold of the Antarctic regions. The southern region is called Patagonia. It is a plateau covered with coarse tufted grass, which provides food for millions of sheep. The shepherds are mostly Scotch.

On the extreme southern section of the Patagonian plateau near the Straits of Magellan there live a small number of Indians who eke out a precarious existence by roaming the wind-swept channels in search of whales, seals, and fish.

Between this plateau and the estuary of the Rio de la Plata the Pampas reach down to the sea. Here is to be seen the most wonderful agricultural development of the present day. The principal port of this region is Bahia Blanca, which is one of the world's greatest wheat-shipping and wool-shipping ports.

At the present time, Argentina stands fifth in wheat production, being exceeded by the United States, Canada, India, and France. In wheat exportation she is only outclassed by Canada. As the railways continue to extend there is little doubt that Canada will soon be rivalled by this South American competitor, more especially when one realizes that the present railway mileage in Argentina is only 22,000 miles, which is just a little more than half Canada's mileage.

Ports of Route—

Para, port in Brazil—Principal rubber-exporting port in South America, also exports coffee.

Penambuco—Coffee, hemp, cotton.

Bahia Blanca—Wool, frozen mutton, beef, cattle, hides, etc.

Rio de Janeiro, chief port in Brazil—Exports coffee, rubber, tobacco.

Buenos Aires, chief port in Argentina—Exports gold, silver, copper, wool, grain.

Montevideo, chief port of Uruguay—Exports hides, beef, wool.

Rosario, river port in Argentina—Wheat, corn, chilled beef, hides, etc.

Santos—The world's greatest coffee port. Also exports large and ever-increasing quantities of chilled beef. This port is destined to be the greatest port of South America north of the River Plata.

325. Canada to the West Indies. This trade route is a pioneer one in many respects. In 1912 Canada entered into a ten-year reciprocal preferential trade agreement with the main group of these islands, and also granted preference without reciprocity to Jamaica, British Honduras and the Bahamas. In making this agreement she formed a trading connection that gives every promise of becoming one of the important features of her commercial development. This trade alliance is a natural one because Canada is wholly a northern country and these islands are purely tropical countries. They are also nearer to each other than to any other portion of the empire. Each offers the other an ideal opportunity for the interchange of their surplus products.

The effect on Canada's overseas trade has been very marked. In 1916 Canada sent to these islands $7,059,370 worth of Canadian products, and purchased from them $22,525,700 worth of such commodities as sugar, molasses, cocoa, coffee, spices, cocoanuts, and bananas. In 1923 Canada's exports had grown to $13,148,000 and her purchases in these regions were $18,255,000. This shows that her sales in the seven-year period had nearly

doubled, whilst her purchases had somewhat fallen off. This was in part due to the fall in the price of sugar, which had reached a high price during the war. The development of this trade route means increased prosperity for Canada.

326. Aerial Transportation. In the last few years great attention is being paid to aerial transportation. Man has conquered land distances by his railways and autos. He has by his ships made the ocean his servant. He is now turning his attention to the air. At present only mail packages, passengers, and light parcels can be carried. In Europe regular lines of airships are in operation. In Australia there is a regular service by aeroplane from Melbourne in the south to Port Darwin on the northern coast. Eleven aerodrome stations have been erected along this route. In Canada the aeroplane is being used with great success as a means of fire patrol and protection of our great forest reserves.

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